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BOSTON SOCIETY OF CIVIL ENGINEERS**FOUNDED 1848**

PAPERS AND DISCUSSIONS

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FLOOD FLOWS OF NEW ENGLAND RIVERS

By C. H. PIERCE,* MEMBER, BOSTON SOCIETY OF CIVIL ENGINEERS

It is frequently remarked that New England is different from most other sections of the country. This may be true, especially in some of its meteorologic and physiographic characteristics, and among the ways in which New England may be congratulated on being different the relative infrequency of devastating floods is noteworthy. In some of the western, central and southern states a year seldom passes without the occurrence of destructive floods; but the rivers of New England follow their courses, somewhat ruffled at times by ice and spring freshets, but generally keeping to their own channels or utilizing their old flood plains. Occasionally the works of men have encroached upon the flood plains to which the rivers have retained their prescriptive rights from time immemorial, in which cases the waters have sometimes taken back their own and inflicted more or less severe penalties. The main river channels have been obstructed by numerous dams, some of them holding in check large masses of water at heights far above the natural channel. Occasionally a dam has failed, and the water has taken toll; or the artificial lake above a dam may have been allowed to rise beyond the point of safety, — with unforeseen and unfortunate results. Encroachments upon the river channels and their

* District Engineer, Water Resources Branch, United States Geological Survey, Custom House, Boston, Mass.

flood plains, and the failures of man-made dams and their appurtenances, have been the principal causes of flood damages in New England. However, with the exception of a very few rivers which are regulated by storage, there occur each year one or more periods of high water, — floods we will call them by courtesy. Some years there are several floods, and other years perhaps only one high-water period.

For the purposes of this discussion it will be assumed that there occurs at least one "flood" each year when the river is at its highest, even if the highest stage reached during the year may have been only "bank full," or even less, in magnitude. This highest stage will be called the "annual flood," or "one-year flood," and will of course vary in magnitude on different years and for different rivers. On some one year the annual flood on any river would be less than any of the other annual floods on the same river. By definition the annual flood of a river which is less than all the other annual floods of that river will be called the "least annual flood," or "lowest one-year flood" of that individual river. On some years there would be likely to occur several periods during which river stages rose above the stage of the least annual flood. By definition, all these river stages equal to or greater than that of the least annual flood will be called "floods," so that if there is one flood every year, there will be several floods on some years. Here, again, is found one of the New England characteristics, for the records show that these so-called floods may occur at any time during the year, and often follow a low-water period. For instance, on the Westfield River in western Massachusetts the least annual flood during the 14-year period 1910-1923 had a peak stage of 12.2 second-feet per square mile, as measured at Knightville, drainage area 162 square miles, and during this period there were 76 floods equal to or greater than that one. The distribution of these floods by months was as follows:

January	5	July	2
February	3	August	1
March	18	October	5
April	23	November	3
May	8	December	5
June	3		

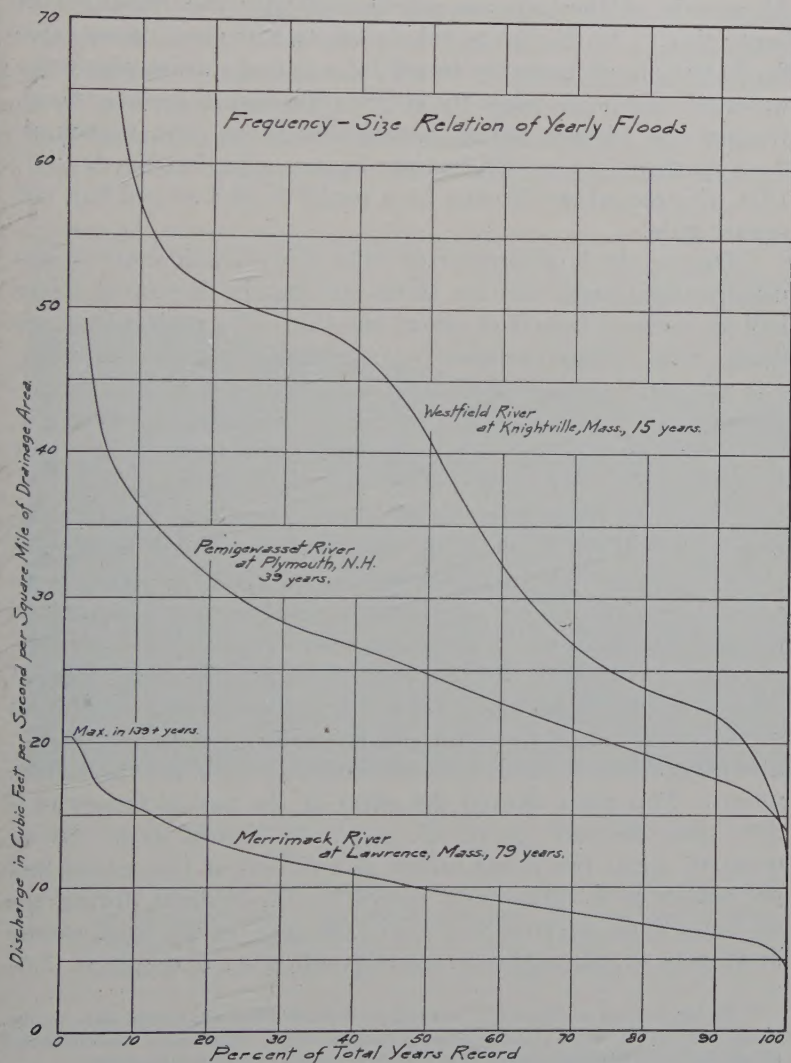


FIG. 1. — FREQUENCY — SIZE RELATION OF YEARLY FLOODS.

The highest flood during each year of continuous record was used in plotting curves. See station records on pages 345, 350 and 362.

All months of the year are represented with the exception of September.* In the list as tabulated, two or more consecutive floods were in all cases separated by a period during which the water fell to a point below the stage of the lowest one-year flood. During the 14-year period mentioned above, the maximum flood reached 52.6 second-feet per square mile, but on April 7, 1924, this record was broken by a peak† of 64.8 second-feet per square mile.

During the late summer of 1923 many rivers went to unusually low stages, and for three months the Westfield River had an average run-off of about one-third of a second-foot per square mile. This condition prevailed up to October 23, when at 5 P.M. the flow of the river at Knightville was only 0.25 second-feet per square mile, but at 7.30 the next morning the river was up to 30.1 second-feet per square mile, — an increase of about 12,000 per cent in $14\frac{1}{2}$ hours.

Floods on rivers like the Westfield, Deerfield, and Pemigewasset, which drain areas of comparatively steep slope, are likely to reach higher stages and also to reach the peak more quickly than do floods on rivers having gentler slopes, even though draining areas of the same size. The highest unit run-off which has been recorded at any gaging station of the United States Geological Survey in New England was 136 second-feet per square mile, on the Deerfield River at Charlemont, Mass., at 11 P.M. July 8, 1915 (for net drainage area of 332 square miles). This peak showed the effect of the partial failure of a dam some distance above the gage, the natural peak having occurred about two hours earlier at a run-off of 126 second-feet per square mile. The total run-off at Charlemont during the 48 hours when the river was above the stage of the least annual flood was 46,800 acre-feet, corresponding to a depth of 2.64

* On the morning of September 10, 1924, the Westfield River was at flood stage, the discharge at Knightville being 14.6 second-feet per square mile. Therefore, in the fifteen-year period 1910-1924, floods have occurred so that every calendar month is represented.

† The records on Westfield River at Knightville started August 26, 1909. For information regarding the highest known flood on Westfield River, that of December 10, 1878, see report made by Hiram F. Mills to the town of Westfield (summarized on pages 124-125 of the Report of the Commission on Waterways and Public Lands on the Water Resources of the Commonwealth of Massachusetts, 1918). The peak of the 1878 flood probably exceeded 150 second-feet per square mile at Knightville.

inches on the tributary 332 square miles. Only one rainfall record was available in the river basin above the gage, and that one showed a precipitation of 4.94 inches during and immediately preceding the flood, but on the previous week 3.26 inches had fallen. In the upper Connecticut River basin, and in northern Vermont and northern Maine the precipitation was con-

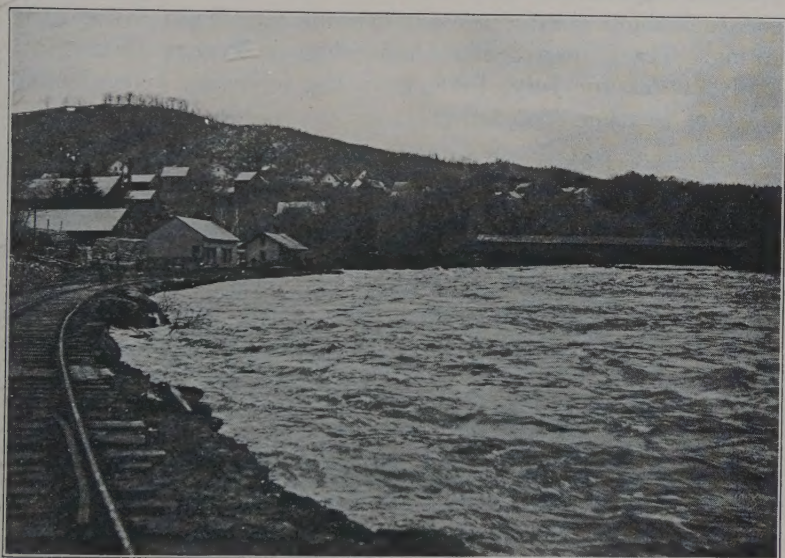


FIG. 2. — PEMIGEWASSET RIVER AT BRISTOL, N. H., DURING THE FLOOD OF APRIL 15 AND 16, 1895.

Within an hour after this view was taken the railroad track, which is 16 feet above low water, had been washed out. The river rose to within 8 inches of the covered bridge seen on right. Discharge at Plymouth was 49.2 second-feet per square mile on the afternoon of April 15.

siderably less than the above figures and there were no floods of any consequence, whereas the Pemigewasset River at Plymouth, N. H., rose to a stage of 21.9 second-feet on July 9, and the Merrimack River at Lowell reached 9.0 second-feet per square mile on July 10. When one flood has occurred it is entirely in order to expect another, and during the first week of August,

1915, some of the rivers rose to higher stages than were recorded for July. The peak of 52.6 second-feet per square mile on the Westfield River at Knightville, Mass., August 4, 1915, was the highest for 14 years (1910-1923) but was exceeded by the peak of April 7, 1924. The floods of July, 1915, following as they did a period of unusually low water for June, were of peculiar interest, especially as they were of a local rather than a general nature and occurred during midsummer instead of the early spring. The United States Climatological Report: New England Section, for July, 1915, gave the following general summary of weather conditions:

The marked feature of the month was the unusually heavy rainfall, the average amount being the greatest, with one exception, of any July in the record of the section.* The large amount that fell at the beginning of the month saturated the ground and completely relieved the drought that had prevailed through the spring. Following this a storm of considerable energy, for the season, passed over the section on the 8th and 9th, giving additional heavy rainfall, between 3 and 4 inches falling over the greater portion of Maine and New Hampshire, and between 2 and 3 inches over nearly all of the remainder of the section. This storm was most severe on the Maine coast, with high winds and heavy rain, more than 6 inches falling at some points on the coast during the night of the 8th. The ground being already saturated, much damage was done to highways, and, in connection with the high wind, to growing crops. In portions of western Massachusetts and in the (lower) Connecticut Valley flood conditions occurred, causing washouts in railroads and highways, carrying away hay on low lands, submerging uncut grass, and covering meadows and intervalles with mud. Showers were frequent, with much cloudy weather, during the remainder of the month, the continued rain and absence of sunshine preventing cultivation and causing more or less damage to growing crops, particularly to hay and corn. A peculiar feature of the conditions of the month was the small amount of rain that occurred in eastern Rhode Island and a small portion of southeastern Massachusetts, where it was below the normal, with complaint of dry weather.

It may not always be desirable to measure the size of a flood by the peak stage alone, for the total amount of water discharged during the period may be the important factor. Seven-

* Note that the Climatological Report for June called attention to a deficiency in precipitation, and made the following statement: "The continued deficiency in rainfall has made the spring and early summer of the present year the driest of record for the section, covering the period since 1888."

teen years' records of the St. John River at Van Buren, Maine, drainage area 8,270 square miles, showed a maximum peak of only 16.2 second-feet per square mile (May 2, 1923), but the flood lasted for a period of fourteen days and gave a run-off of 2,687,000 acre-feet. The flood of longest duration and greatest discharge for the St. John River (May 20, 1919) lasted for 33 days and discharged 5,333,000 acre-feet. It is also of interest to note that during the 17 years there were only 27 floods, a small showing compared with the Westfield River, previously mentioned.



FIG. 3. — LOOKING DOWN THE MERRIMACK RIVER AT PENACOOK, N. H., DURING THE FLOOD OF APRIL 15 AND 16, 1895 (CONTOOCOOK RIVER ENTERS ON RIGHT).

The peak stage of the flood of March 2 and 3, 1896, exceeded the peak of the flood of April 15 and 16, 1895, for the river below Concord, although the 1896 flood was not of as long duration. For points above Franklin, the 1895 flood was probably the greater.

The amount and distribution of rainfall, number of lakes and ponds in the river basin, surface configuration of the tributary area, possible accumulation of snow and ice, ground-water elevation, character of vegetation, forests, etc., introduce so many variable factors that it is difficult to make comparisons of river flow except in a very general way. It is also true that most of the records for which complete flood flow data are avail-

able are for comparatively short periods of time, except for the larger river basins. The smaller drainage areas for which long time records are available are generally so largely affected by reservoir storage that floods are entirely eliminated, although those records do in some cases give a fairly good idea of the approximate flood run-off. The report of the Committee on Run-off, Boston Society of Civil Engineers (JOURNAL of the Boston Society of Civil Engineers, October, 1922), contained on page 212 a list of the gaging stations in New England for which reliable stream flow records were at that time available, also on pages 192-204 a grading of the records to indicate their comparative accuracy. Eliminating from that list those rivers where the flow was largely regulated by storage, the records available for flood flow studies may be grouped as follows:

SIZE OF DRAINAGE AREA (SQUARE MILES)	Number of Stations	Length of Longest Record (Years*)
0- 50	4	10
50- 100	7	14
100- 200	13	15
200- 300	6	22
300- 400	4	11
400- 500	6	18
500-1,000	8	39
1,000-1,500	4	22
1,500-2,000	2	22
2,000-3,000	2	12
3,000-4,000	2	27
4,000-5,000	4	79
5,000-7,500	1	23
Over 7,500	3	21

* Including records available up to 1924.

From the above list it may be seen that records of run-off from small drainage areas are available for flood flow studies only for comparatively short periods of time. A number of gaging stations on small rivers have been started since the date of the Run-off Committee's report, and, unfortunately, some others have been discontinued, but it is hoped that each year

may show some increases in the number as well as the length of records available.

In regard to estimates of floods, which are of vital importance in many problems of engineering design and construction, it is probably true that undue weight is often given to formulas and diagrams originally intended to show only the most general relations. Those formulas are, in most cases, either built upon fragmentary data scattered over a wide area, or designed to fit the characteristics of individual rivers. It is suggested that the more logical way to estimate the probable maximum flood in any individual case would be to make a careful study of the basin under consideration, as to its physiography, surface configuration and hydrologic conditions, and then to compare it with other rivers of similar characteristics for which actual flood flow data are available.

The limits of this paper do not permit a description of all the important floods which are known to have occurred in New England. However, a compilation of data has been made for a number of rivers and the following list shows in condensed form the essential facts. There undoubtedly exists a large amount of additional information pertaining to this subject, and it is hoped that members of the Boston Society of Civil Engineers and others having such information may contribute the same for publication.

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TABLES OF FLOOD FLOW DATA FOR RIVERS AND RIVER STATIONS IN NEW ENGLAND

ST. JOHN RIVER AT VAN BUREN, MAINE

(Drainage area, 8,270 sq. mi.)

Records for 17 years, 1908 to 1924.

Greatest flood in above period, 134,000 c. f. s., May 2, 1923 (river at flood stage 14 days).

Second largest flood, 121,000 c. f. s., May 13, 1909 (river at flood stage 17 days); and 121,000 c. f. s., May 3 and 4, 1911 (river at flood stage 13 days).

Third largest flood, 119,000 c. f. s., April 29, 1913 (river at flood stage 11 days).

Lowest one-year flood, 57,500 c. f. s., May 7, 1910.

Floods during Period of Daily Records

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
May 4, 1908	100,000	May 15, 1917	75,000
May 13, 1909	121,000	June 20, 1917	92,700 P
Oct. 1, 1909	67,800	May 2, 1918	104,000
May 7, 1910	57,500	May 20, 1919	102,000 P
May 3 and 4, 1911 . .	121,000	April 24, 1920	60,200
May 15, 1912	92,400	May 11, 1920	104,000
June 2, 1912	97,900	Oct. 3, 1920	67,200
April 29, 1913	119,000	March 31, 1921	68,000
June 2, 1913	83,900	April 30, 1921	89,400
May 12, 1914	104,000 P	April 21, 1922	74,400
May 18, 1915	83,000	June 20, 1922	108,000 P
May 9, 1915	87,500 P	May 2, 1923	134,000 P
April 26 and 27, 1916 .	84,900 P	May 17, 1924	110,000 P
April 25, 1917	72,600		

NOTE. — Gage read once a day except those marked P, which are the higher of two or more readings.

MACHIAS RIVER AT WHITNEYVILLE, MAINE

(Drainage area, 465 sq. mi.)

Records for 18 years, 1904 to 1921.

Greatest flood in above period, 11,100 c. f. s., Sept. 30, 1909 (river at flood stage 6 days).

Second largest flood, 9,200 c. f. s., April 7, 1920 (river at flood stage 38 days).

Third largest flood, 8,160 c. f. s., March 30, 1909 (river at flood stage 7 days).

Lowest one-year flood, 3,500 c. f. s., March 26, 1921.

Floods during Period of Daily Records

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
April 11, 1904 . . .	5,860	Nov. 10, 1912 . . .	4,690
April 30, 1904 . . .	4,280	Jan. 5, 1913 . . .	4,180
May 13, 1904 . . .	7,680	March 28, 1913 . . .	5,900
April 1, 1905 . . .	5,590	May 31, 1913 . . .	4,180
April 8, 1905 . . .	4,820	April 10, 1914 . . .	5,680
April 16, 1906 . . .	5,460	April 21, 1914 . . .	5,570
May 29, 1906 . . .	5,130	June 5, 1914 . . .	3,580
April 25, 1907 . . .	5,020	Feb. 27, 1915 . . .	4,280
Feb. 17, 1908 . . .	4,280	May 2 and 3, 1915 . . .	6,780
March 17, 1908 . . .	3,780	July 10, 1915 . . .	5,130
May 2, 1908 . . .	4,080	May 18, 1916 . . .	4,380
June 3, 1908 . . .	3,580	March 31, 1917 . . .	4,580
Jan. 7, 1909 . . .	5,680	April 8, 1917 . . .	5,020
March 30, 1909 . . .	8,160	June 18, 1917 . . .	6,780
April 17, 1909 . . .	6,780	April 22 and 23, 1918 . . .	5,900
May 8, 1909 . . .	3,580	May 2, 1918 . . .	4,800
Sept. 30, 1909 . . .	11,100	Sept. 28, 1918 . . .	3,950
Nov. 27, 1909 . . .	5,020	Oct. 7, 1918 . . .	4,800
March 8, 1910 . . .	5,130	March 23, 1919 . . .	4,360
April 29 and 30, 1910 . . .	3,680	May 27, 1919 . . .	5,790
March 30, 1911 . . .	4,580	Nov. 7, 1919 . . .	3,950
April 24, 1912 . . .	3,880	April 7, 1920 . . .	9,200
June 1, 1912 . . .	5,680	Dec. 16, 1920 . . .	4,470
Oct. 26, 1912 . . .	6,340	March 26, 1921 . . .	3,500

NOTE. — Gage read once a day.

EAST BRANCH OF PENOBSCOT RIVER AT GRINDSTONE, MAINE

(Drainage area, 1,070 sq. mi.)

Records for 22 years, 1903 to 1924.

Greatest flood in above period, 35,100 c. f. s., April 30, 1923 (river at flood stage 11 days).

Second largest flood, 24,800 c. f. s., Sept. 29, 1909 (river at flood stage 4 days).

Third largest flood, 18,700 c. f. s., June 19, 1917 (river at flood stage 7 days).

Lowest one-year flood, 6,730 c. f. s., July 5, 1916.

Floods during Period of Daily Records

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
March 25 and 26, 1903 .	10,200	Oct. 21, 1913 . . .	7,730
May 2, 1904 . . .	12,600	May 10, 1914 . . .	16,200 P
May 13, 1904 . . .	8,790	May 5, 1915 . . .	10,200 P
May 21, 1904 . . .	7,470	July 5, 1916 . . .	6,730 P
May 29, 1904 . . .	7,220	April 24, 1917 . . .	10,200
April 7, 1905 . . .	7,350	June 19, 1917 . . .	18,700 P
May 7 and 8, 1906 . . .	11,700 P	Oct. 31, 1917 . . .	7,990
June 8-11, 1906 . . .	6,730	April 24, 1918 . . .	6,970
May 2, 1907 . . .	17,900 P	May 2, 1918 . . .	7,730
June 29, 1907 . . .	8,120	July 9, 1918 . . .	12,300 P
May 2, 1908 . . .	13,700 P	March 31, 1919 . . .	7,220
June 1, 1908 . . .	9,480	April 11, 1919 . . .	8,790
April 16, 1909 . . .	11,700	April 26, 1919 . . .	9,910 P
May 11, 1909 . . .	14,500	May 19, 1919 . . .	7,220
Sept. 29, 1909 . . .	24,800 P	May 27, 1919 . . .	7,730
April 7, 1910 . . .	8,250 P	April 15, 1920 . . .	11,700
June 4, 1910 . . .	8,250	May 10, 1920 . . .	13,500 P
May 3, 1911 . . .	9,910 P	Oct. 2, 1920 . . .	9,340
April 24, 1912 . . .	12,900 P	March 29, 1921 . . .	12,000 P
May 31 and June 1, 1912 .	10,400	April 17, 1921 . . .	6,730
Oct. 26, 1912 . . .	17,200 P	April 26, 1921 . . .	7,470
Nov. 9, 1912 . . .	11,800	June 23, 1922 . . .	13,900 P
April 3, 1913 . . .	11,400	April 30, 1923 . . .	35,100 P
April 25, 1913 . . .	8,520	May 2, 1924 . . .	13,900 P
June 1, 1913 . . .	8,250		

NOTE. — Discharge represents average for 24 hours, except those marked P, which are the higher of two readings a day.

MATTAWAMKEAG RIVER AT MATTAWAMKEAG, MAINE

(Drainage area, 1,500 sq. mi.)

Records for 22 years, 1903 to 1924.

Greatest flood in above period, 43,900 c. f. s., May 1, 1923 (river at flood stage 18 days).

Second largest flood, 25,600 c. f. s., April 18, 1920 (river at flood stage 41 days); and 25,600 c. f. s., May 2, 1907 (river at flood stage 18 days).

Third largest flood, 23,300 c. f. s., June 20, 1917 (river at flood stage 12 days).

Lowest one-year flood, 10,200 c. f. s., April 6, 1916.

Floods during Period of Daily Records

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
March 25, 1903 . .	17,400 P	May 10 and 11, 1914 . .	20,800
April 14, 1904 . .	12,800	April 17, 1915 . .	10,400
May 15, 1904 . .	18,000 P	May 6 and 7, 1915 . .	16,400 P
April 2, 1905 . .	21,600 P	April 6, 1916 . .	10,200 P
April 9 and 10, 1905 . .	12,700	April 25, 1917 . .	17,700
May 6-8, 1906 . .	16,100	May 13, 16, 17, 1917 . .	10,200
May 2, 1907 . .	25,600 P	June 20, 1917 . .	23,300
May 2, 1908 . .	17,700 P	April 26, 1918 . .	12,400
April 20 and 21, 1909 . .	21,600	May 3, 1918 . .	10,500
Sept. 30, 1909 . .	13,200	March 31-April 2, 1919 . .	13,000
April 25, 1910 . .	10,900	April 15-18, 1919 . .	12,400
May 2, 1911 . .	11,600 P	April 18, 1920 . .	25,600 P
April 22, 1912 . .	12,200	April 2, 1921 . .	15,300 P
June 3, 1912 . .	20,000 P	April 14 and 15, 1922 . .	13,300
Nov. 10, 1912 . .	15,000	June 24, 1922 . .	17,400 P
April 29, 1913 . .	21,000	May 1, 1923 . .	43,900 P
Oct. 30, 1913 . .	11,000	May 3, 1924 . .	14,200

NOTE. — Discharge represents average for 24 hours, except those marked P, which are the higher of two readings a day.

PISCATAQUIS RIVER NEAR FOXCROFT, MAINE

(Drainage area, 286 sq. mi.)

Records for 22 years, 1903 to 1924.

Greatest flood in above period, 21,700 c. f. s., Sept. 29, 1909 (river at flood stage 2 days).

Second largest flood, 21,200 c. f. s., April 29, 1923 (river at flood stage 5 days).

Third largest flood, 19,800 c. f. s., June 18, 1917 (river at flood stage 3 days).

Lowest one-year flood, 4,110 c. f. s., May 2, 1918.

Floods during Period of Daily Records

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
March 12, 1903 . .	14,200 P	Nov. 10, 1913 . .	4,240
March 18, 1903 . .	4,150	April 21, 1914 . .	8,730
March 24, 1903 . .	6,330	April 29, 1914 . .	5,460
June 14, 1903 . .	5,750	May 10, 1914 . .	8,530
April 11, 1904 . .	13,900 P	Feb. 26, 1915 . .	9,500 P
May 1, 1904 . .	5,840	April 13, 1915 . .	7,110
May 12, 1904 . .	8,220	May 1, 1915 . .	7,510
May 17, 1904 . .	5,080	April 2, 1916 . .	6,040
April 1, 1905 . .	8,420	April 19, 1916 . .	5,270
April 7, 1905 . .	9,240 P	May 18, 1916 . .	7,810 P
April 17, 1906 . .	14,200 P	Dec. 1, 1916 . .	6,820
May 2, 1906 . .	4,340	March 29, 1917 . .	7,210
May 10, 1906 . .	8,020	April 7, 1917 . .	9,040
May 1, 1907 . .	10,700	April 23, 1917 . .	6,620
Oct. 30, 1907 . .	4,340	June 18, 1917 . .	19,800 P
Nov. 7, 1907 . .	14,200 P	July 31, 1917 . .	7,810
Dec. 11, 1907 . .	10,100	Oct. 31, 1917 . .	4,830
April 29, 1908 . .	9,040	May 2, 1918 . .	4,110
April 15, 1909 . .	11,200	March 29, 1919 . .	4,350 P
May 13, 1909 . .	4,700	April 7, 1920 . .	5,600
Sept. 29, 1909 . .	21,700 P	April 14, 1920 . .	7,600 P
April 2, 1910 . .	4,890 P	April 29, 1920 . .	4,230
April 16, 1911 . .	7,210 P	May 9, 1920 . .	5,070
April 30, 1911 . .	4,800	Oct. 1, 1920 . .	4,710
April 18, 1912 . .	5,650	Dec. 15, 1920 . .	4,830
April 23, 1912 . .	10,300 P	March 26, 1921 . .	4,470
May 31, 1912 . .	5,460	April 12, 1922 . .	5,550
Oct. 26, 1912 . .	7,910	June 19, 1922 . .	4,110
Nov. 8, 1912 . .	7,010	June 22, 1922 . .	4,230
March 22, 1913 . .	8,220	June 30, 1922 . .	7,350 P
March 26, 1913 . .	8,120	April 22, 1923 . .	4,830
April 1, 1913 . .	9,860 P	April 29, 1923 . .	21,200 P
Oct. 21, 1913 . .	8,320	May 2, 1924 . .	7,950 P

NOTE. — Discharge figures are average rate (24 hours), except those marked P, which are the higher of two readings a day.

KENNEBEC RIVER AT WATERVILLE, MAINE

(Drainage area, 4,270 sq. mi. gross, or 3,030 sq. mi. exclusive of area above Moosehead Lake outlet)

Daily records for 33 years, 1892 to 1924, and miscellaneous data for earlier periods.

Greatest known flood in 100 years, 150,000* c. f. s., Dec. 16, 1901 (river at flood stage 3 days).

Second largest known flood, 140,000* c. f. s., May 22, 1832.

Third largest known flood, 135,000* c. f. s., May 1, 1923 (river at flood stage 7 days).

Lowest known one-year flood, 27,900 c. f. s., April 16, 1911.

Floods during Period of Daily Records

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
June 29 and July 4, 1892 .	30,000	April 16, 1911 . . .	27,900
May 18, 1893 . . .	83,500	April 24, 1912 . . .	45,500
April 23, 1894 . . .	35,300	June 1, 1912 . . .	36,300
April 15, 1895 . . .	86,200	March 25, 1913 . . .	43,400
March 2, 1896 . . .	111,000	April 21, 1914 . . .	57,000
April 21, 1896 . . .	74,500	May 10, 1914 . . .	54,300
Nov. 6, 1896 . . .	29,900	Feb. 27, 1915 . . .	31,600
April 28, 1897 . . .	66,900	April 12, 1915 . . .	41,700
July 15, 1897 . . .	55,600	May 2, 1915 . . .	44,200
April 25, 1898 . . .	52,100	July 10, 1915 . . .	39,700
April 27, 1899 . . .	45,800	April 24, 1916 . . .	35,400
April 21, 1900 . . .	62,300	May 19, 1916 . . .	44,500
April 9, 1901 . . .	76,600	April 7, 1917 . . .	40,900
Dec. 16, 1901 . . .	156,800 P	June 18, 1917 . . .	88,500
March 30, 1902 . . .	58,000	Aug. 1, 1917 . . .	34,000
May 1, 1902 . . .	34,400	April 3, 1918 . . .	52,900
June 27, 1902 . . .	33,900	May 2, 1918 . . .	33,900
March 20, 1903 . . .	35,700	Nov. 22, 1918 . . .	39,800
June 14, 1903 . . .	30,000	March 24, 1919 . . .	39,800
May 12, 1904 . . .	37,800	April 14, 1919 . . .	31,000
April 1, 1905 . . .	32,100	May 3, 1919 . . .	30,800
April 16, 1906 . . .	39,400	April 15, 1920 . . .	54,300
May 11, 1906 . . .	34,400	May 10, 1920 . . .	37,100
April 25, 1907 . . .	41,400	Oct. 2, 1920 . . .	29,600
June 2, 1907 . . .	47,300	Dec. 16, 1920 . . .	34,200
Nov. 8, 1907 . . .	71,200	March 27, 1921 . . .	37,900
April 29, 1908 . . .	29,200	April 13, 1922 . . .	60,600
April 16, 1909 . . .	44,200	June 20, 1922 . . .	30,000
May 11, 1909 . . .	38,500	July 2, 1922 . . .	34,300
June 3, 1909 . . .	30,200	May 1, 1923 . . .	135,200 P
April 7, 1910 . . .	36,000	May 2, 1924 . . .	36,200

* For net drainage area of 3,030 sq. mi., after subtracting estimated discharge from Moosehead Lake.

NOTE. — With the exception of those marked P the figures are supposed to represent average rate per 24 hours, but in most cases are taken from one reading a day, and show total flow at Waterville. Data furnished by Hollingsworth & Whitney Company.

LITTLE ANDROSCOGGIN RIVER NEAR SOUTH PARIS, MAINE

(Drainage area, 75 sq. mi.)

Records for 10 years, 1914 to 1923.

Greatest flood in above period, 3,540 c. f. s., April 14, 1920 (river at flood stage 1 day).

Second largest flood, 2,970 c. f. s., July 9, 1915 (river at flood stage 1 day).

Third largest flood, 2,900 c. f. s., April 29, 1923 (river at flood stage 2 days).

Lowest one-year flood, 1,280 c. f. s., March 29, 1919.

Floods during Period of Daily Records

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
April 21, 1914 . . .	2,570 P	March 28, 1920 . . .	1,280
Feb. 26, 1915 . . .	2,470	April 6, 1920 . . .	2,070
July 9, 1915 . . .	2,970 P	April 14, 1920 . . .	3,540 P
April 24, 1916 . . .	1,320	April 22, 1920 . . .	1,470
May 18, 1916 . . .	2,420 P	Dec. 15, 1920 . . .	2,670
April 7, 1917 . . .	1,280	March 26, 1921 . . .	1,500
June 12, 1917 . . .	2,070	April 12, 1922 . . .	2,350 P
Sept. 26, 1918 . . .	1,970	June 19, 1922 . . .	1,500
March 29, 1919 . . .	1,280	April 29, 1923 . . .	2,900 P

NOTE. — Discharge figures are for one reading a day, except those marked P, which correspond to the higher of two or more readings.

SACO RIVER AT CORNISH, MAINE

(Drainage area, 1,300 sq. mi.)

Records for 8 years, 1917 to 1924.

Greatest flood in above period, 23,000 c. f. s., May 2, 1923 (river at flood stage 18 days).

Second largest flood, 18,000 c. f. s., April 14, 1922 (river at flood stage 18 days).

Third largest flood, 17,400 c. f. s., June 18, 1917 (river at flood stage 14 days).

Lowest one-year flood, 7,560 c. f. s., April 7, 1918.

Floods during Period of Daily Records

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
April 7, 1917 . . .	10,400 A	March 28, 1921 . . .	12,600 P (12,600 A)
April 27, 1917 . . .	10,900 A	April 1, 1922 . . .	7,600 A
June 18, 1917 . . .	17,400 P (16,900 A)	April 14, 1922 . . .	18,000 P (17,800 A)
April 7, 1918 . . .	7,560 P (7,560 A)	May 10, 1922 . . .	9,400 A
March 31, 1919 . . .	13,500 P (13,300 A)	June 25, 1922 . . .	11 600 A
May 26, 1919 . . .	8,800 A	April 12, 1923 . . .	10,800 A
April 25, 1920 . . .	14,100 P (14,000 A)	May 2, 1923 . . .	23,000 P (22,800 A)
Dec. 18, 1920 . . .	8,800 A	May 4, 1924 . . .	12,900 P (12,700 A)

NOTE. — Figures marked A are average rate of flow for 24 hours; those marked P are for peak stage.

SACO RIVER AT WEST BUXTON, MAINE

(Drainage area, 1,500 sq. mi.)

Records for 17 years, 1908 to 1924.

Greatest flood in above period, 27,800 c. f. s., May 2, 1923 (river at flood stage 19 days).

Second largest flood, 20,800 c. f. s., April 18, 1909 (river at flood stage 22 days).

Third largest flood, 19,800 c. f. s., April 14, 1922 (river at flood stage 18 days).

Lowest one-year flood, 9,140 c. f. s., April 6 and 8, 1918.

Floods during Period of Daily Records

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
May 4, 1908 . . .	13,300	April 7, 1917 . . .	12,700
April 18, 1909 . . .	20,800	April 26, 1917 . . .	11,300
April 4, 1910 . . .	10,900	June 18, 1917 . . .	19,400
April 27, 1910 . . .	13,100	April 6 and 8, 1918 . . .	9,140
April 17, 1911 . . .	10,100	March 24, 1919 . . .	9,340
May 4, 1911 . . .	11,000	March 31, 1919 . . .	14,200
April 8, 1912 . . .	10,500	May 26, 1919 . . .	9,990
April 20, 1912 . . .	13,000	April 24, 1920 . . .	17,400
March 29, 1913 . . .	15,800	Dec. 16, 1920 . . .	9,640
March 4, 1914 . . .	9,470	March 23, 1921 . . .	14,300
April 3, 1914 . . .	9,760	April 26, 1921 . . .	15,600
April 11, 1914 . . .	9,560	March 30, 1922 . . .	10,300
April 23, 1914 . . .	16,000	April 14, 1922 . . .	19,800
May 12, 1914 . . .	9,420	May 9, 1922 . . .	11,600
Feb. 27, 1915 . . .	9,290	June 22, 1922 . . .	14,900
April 3, 1916 . . .	10,300	July 4, 1922 . . .	9,420
April 27, 1916 . . .	14,100	April 13, 1923 . . .	12,900
May 18, 1916 . . .	12,400	May 2, 1923 . . .	27,800
June 14, 1916 . . .	12,000	May 5, 1924 . . .	14,400

NOTE.—Figures represent average rate for 24 hours. Data furnished by Cumberland County Power and Light Company.

PEMIGEWASSET RIVER AT PLYMOUTH, N. H.

(Drainage area, 615 sq. mi.)

Records for 39 years, 1886 to 1924.

Greatest flood in above period, 30,200 c. f. s., April 15, 1895 (river at flood stage 3 days).

Second largest flood, 24,900 c. f. s., March 1, 1896 (river at flood stage 2 days).

Third largest flood, 22,400 c. f. s., April 29, 1923 (river at flood stage 3 days).

Lowest one-year flood, 8,510 c. f. s., April 27, 1910.

Floods during Period of Daily Records

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
April 2, 1886 . . .	19,500	Dec. 22, 1895 . . .	10,100
April 16, 1886 . . .	9,000	Dec. 27, 1895 . . .	12,000 P
April 19, 1886 . . .	10,800	Dec. 31, 1895 . . .	16,300 P
Nov. 19, 1886 . . .	12,400	March 1, 1896 . . .	24,900
April 12, 1887 . . .	14,100	April 17, 1896 . . .	14,100
April 25, 1887 . . .	10,100	Oct. 22, 1896 . . .	9,450
May 5, 1887 . . .	12,800	Nov. 6, 1896 . . .	14,800
June 24, 1887 . . .	15,400	April 16, 1897 . . .	9,450
April 30, 1888 . . .	16,800	April 26, 1897 . . .	11,100
May 13, 1888 . . .	15,100	May 14, 1897 . . .	16,500
June 2, 1889 . . .	9,450	June 10, 1897 . . .	13,200 P
April 15, 1890 . . .	10,500	July 15, 1897 . . .	21,800
May 7, 1890 . . .	13,500	Dec. 16, 1897 . . .	12,800
May 21, 1890 . . .	12,800	March 21, 1898 . . .	8,780
May 27, 1890 . . .	12,100 P	April 25, 1898 . . .	9,550
Aug. 27, 1890 . . .	11,000 P	May 13, 1898 . . .	11,500
Sept. 14, 1890 . . .	12,100	Oct. 27, 1898 . . .	9,200 P
Sept. 17, 1890 . . .	10,900	April 27, 1899 . . .	11,800
April 12, 1891 . . .	10,800	May 2, 1899 . . .	12,600
April 20, 1891 . . .	12,100	Feb. 14, 1900 . . .	22,200
April 24, 1891 . . .	10,900	April 20, 1900 . . .	14,800
Nov. 24, 1891 . . .	8,780	May 20, 1900 . . .	10,600
Jan. 14, 1892 . . .	13,500 P	April 8, 1901 . . .	12,500 P
June 28, 1892 . . .	11,500 P	April 23, 1901 . . .	10,500
Nov. 17, 1892 . . .	12,500	May 20, 1901 . . .	10,100
Nov. 19, 1892 . . .	8,780	Dec. 16, 1901 . . .	17,500
May 5, 1893 . . .	13,200	March 3, 1902 . . .	20,800
May 13, 1893 . . .	10,900	May 1, 1902 . . .	10,100
May 17, 1893 . . .	14,800 P	May 28, 1902 . . .	10,100
Oct. 28, 1893 . . .	10,100 P	Oct. 29, 1902 . . .	14,100
April 22, 1894 . . .	14,100	March 12, 1903 . . .	18,800
May 29, 1894 . . .	11,700	March 21, 1903 . . .	12,900
April 10, 1895 . . .	14,700	March 25, 1903 . . .	11,200
April 15, 1895 . . .	30,200	June 13, 1903 . . .	9,220
Nov. 27, 1895 . . .	11,500	March 27, 1904 . . .	8,800

NOTE.— Discharge figures are for one reading a day, except those marked P, which are for the higher of two readings.

PEMIGEWASSET RIVER AT PLYMOUTH, N. H. — *Concluded**Floods during Period of Daily Records — Concluded*

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
April 10, 1904 . . .	9,180	May 18, 1916 . . .	13,000 P
April 30, 1904 . . .	9,550	March 28, 1917 . . .	11,000 P
May 17, 1904 . . .	9,850	April 23, 1917 . . .	10,800 P
May 20, 1904 . . .	9,310	June 12, 1917 . . .	13,100 P
March 29, 1905 . . .	12,500	June 18, 1917 . . .	13,800 P
March 31, 1905 . . .	8,980	April 3, 1918 . . .	9,550 P
April 16, 1906 . . .	13,100	Sept. 27, 1918 . . .	10,600 P
May 28, 1906 . . .	11,900	Dec. 23, 1918 . . .	8,780 P
May 1, 1907 . . .	11,500	March 29, 1919 . . .	16,000 P
Oct. 29, 1907 . . .	13,000	April 12, 1919 . . .	9,220 P
Nov. 3, 1907 . . .	13,800	May 23, 1919 . . .	14,100 P
Nov. 7, 1907 . . .	10,300	Nov. 15, 1919 . . .	8,780 P
Dec. 11, 1907 . . .	14,800	March 28, 1920 . . .	13,500 P
Feb. 16, 1908 . . .	11,000	April 6, 1920 . . .	8,550 P
April 17, 1908 . . .	9,220	April 14, 1920 . . .	16,200 P
April 29, 1908 . . .	11,400	April 22, 1920 . . .	11,500 P
May 16, 1908 . . .	10,800	April 24, 1920 . . .	9,890 P
May 31, 1908 . . .	9,450	April 29, 1920 . . .	9,450 P
April 8, 1909 . . .	10,600	Oct. 1, 1920 . . .	13,500 P
April 15, 1909 . . .	16,600	Dec. 6, 1920 . . .	11,500 P
April 27, 1910 . . .	8,510	Dec. 15, 1920 . . .	13,200 P
April 15, 1911 . . .	10,200	March 10, 1921 . . .	10,400
May 2, 1911 . . .	9,850	March 22, 1921 . . .	13,200 P
April 8, 1912 . . .	11,600	March 26, 1921 . . .	10,900 P
April 17, 1912 . . .	10,300	April 1, 1921 . . .	11,400 P
April 23, 1912 . . .	10,200	Nov. 20, 1921 . . .	10,000 P
Oct. 25, 1912 . . .	9,610	March 29, 1922 . . .	8,780 P
Nov. 8, 1912 . . .	9,550	April 12, 1922 . . .	16,800 P
March 16, 1913 . . .	12,100	April 19, 1922 . . .	9,550 P
March 22, 1913 . . .	16,500	May 6, 1922 . . .	9,340 P
March 26, 1913 . . .	14,600	June 4, 1922 . . .	9,680 P
March 28, 1913 . . .	18,700	June 23, 1922 . . .	9,890 P
April 1, 1913 . . .	10,500	June 30, 1922 . . .	12,000 P
Nov. 10, 1913 . . .	11,100	April 9, 1923 . . .	13,400 P
March 3, 1914 . . .	12,400	April 23, 1923 . . .	13,800 P
April 21, 1914 . . .	18,400	April 29, 1923 . . .	22,400 P
Feb. 26, 1915 . . .	16,200	Nov. 25, 1923 . . .	9,550 P
March 2, 1915 . . .	9,550 P	Dec. 1, 1923 . . .	11,900 P
April 12, 1915 . . .	10,900 P	April 19, 1924 . . .	10,600 P
July 9, 1915 . . .	13,470 P	Sept. 10, 1924 . . .	13,700 P
April 1, 1916 . . .	11,200 P		

NOTE. — Discharge figures are for one reading a day, except those marked P, which are for the higher of two readings.

MERRIMACK RIVER AT LOWELL, MASS.

(Drainage area, 4,097 sq. mi.* See note.)

Source of data, Records of the Proprietors of Lock and Canals. Records furnished by Arthur T. Safford.

Total length of period of daily records, 72 years, from 1848 to 1861 and from 1867 to 1924.

Greatest known flood in 139 years, 86,000 c. f. s.=21.0 c. f. s. per sq. mi. on April 23, 1852.

Second largest known flood, 85,300 c. f. s.=20.8 c. f. s. per sq. mi. on March 3, 1896.

Third largest known flood, 77,300 c. f. s.=18.9 c. f. s. per sq. mi. on April 16, 1895.

The greatest flood is known to be the maximum in 139 years.

Floods during Period of Daily Records

(Including all flows equalling or exceeding the "one-year flood" (average rate per 24 hours).)

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
May 5, 1848 . . .	32,000	Feb. 21, 1870 . . .	44,200
March 31, 1849 . . .	40,700	March 31, 1870 . . .	27,800
Nov. 12, 1849 . . .	49,300	April 21, 1870 . . .	75,600
May 1, 1850 . . .	58,500	March 14, 1871 . . .	35,200
April 18, 1851 . . .	31,000	May 8, 1871 . . .	33,000
Nov. 1, 1851 . . .	33,400	Nov. 17, 1871 . . .	30,000
April 23, 1852 . . .	86,000 P	April 12, 1872 . . .	41,900
Feb. 8, 1853 . . .	48,700	Aug. 19, 1872 . . .	23,100
May 28, 1853 . . .	39,600	Nov. 14, 1872 . . .	23,500
May 2, 1854 . . .	56,800	April 12, 1873 . . .	42,200
April 21, 1855 . . .	50,600	May 13, 1873 . . .	30,000
Oct. 4, 1855 . . .	35,200	Oct. 22, 1873 . . .	39,900
April 11, 1856 . . .	33,600	Jan. 10, 1874 . . .	46,700
May 7, 1857 . . .	45,800	March 6, 1874 . . .	21,100
Oct. 28, 1857 . . .	38,100	June 19, 1874 . . .	26,200
March 20, 1858 . . .	22,300	July 14, 1874 . . .	27,200
Sept. 18, 1858 . . .	37,200	April 6, 1875 . . .	48,000
March 21, 1859 . . .	60,800	March 30, 1876 . . .	48,050
March 5, 1860 . . .	24,600	April 17, 1876 . . .	44,200
April 16, 1861 . . .	45,700	May 13, 1876 . . .	35,600
April 18, 1867 . . .	41,300	March 29, 1877 . . .	60,000
Aug. 19, 1867 . . .	30,000	Nov. 28, 1877 . . .	28,500
March 20, 1868 . . .	31,900	May 1, 1878 . . .	50,000
May 25, 1868 . . .	46,000	Nov. 25, 1878 . . .	22,500
Sept. 28, 1868 . . .	27,200	Dec. 12, 1878 . . .	69,100
March 31, 1869 . . .	35,100	Feb. 15, 1879 . . .	22,600
April 23, 1869 . . .	50,400	May 1, 1879 . . .	38,500
Oct. 6, 1869 . . .	64,500	April 6, 1880 . . .	29,000
Dec. 31, 1869 . . .	26,000	March 12, 1881 . . .	26,600
Jan. 4, 1870 . . .	51,600	April 26, 1881 . . .	23,500

* The South Branch of the Nashua River (118 sq. mi.) was diverted March 7, 1898, reducing the drainage area to 3,979 sq. mi.

NOTE. — Except where marked P these figures are based upon the 11 A.M. reading at the Boott Mills.

MERRIMACK RIVER AT LOWELL, MASS. — *Continued**Floods during Period of Daily Records — Continued*

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
May 18, 1881 . . .	28,400	March 9, 1894 . . .	25,300
Dec. 31, 1881 . . .	29,700	April 23, 1894 . . .	20,200
March 4, 1882 . . .	34,600	April 16, 1895 . . .	77,300 P
May 30, 1882 . . .	26,900	Nov. 29, 1895 . . .	21,500
April 14, 1883 . . .	36,400	Dec. 24, 1895 . . .	21,200
March 29, 1884 . . .	51,600	Jan. 2, 1896 . . .	27,200
April 19, 1884 . . .	47,500	Feb. 8, 1896 . . .	31,300
April 24, 1885 . . .	24,800	March 3, 1896 . . .	85,300 P
Nov. 10, 1885 . . .	24,800	April 18, 1896 . . .	35,100
Jan. 7, 1886 . . .	41,300	Nov. 7, 1896 . . .	23,800
Feb. 15, 1886 . . .	48,700	May 15, 1897 . . .	27,900
April 3, 1886 . . .	45,700	June 11, 1897 . . .	40,700
Jan. 31, 1887 . . .	28,200	July 16, 1897 . . .	47,000
April 13, 1887 . . .	46,600	Dec. 17, 1897 . . .	40,400
May 2, 1887 . . .	33,000	March 15, 1898 * . .	39,600
June 25, 1887 . . .	29,900	April 26, 1898 . . .	32,600
July 26, 1887 . . .	24,800	April 17, 1899 . . .	40,900
Aug. 26, 1887 . . .	23,100	Feb. 14, 1900 . . .	53,300
May 1, 1888 . . .	44,500	March 3, 1900 . . .	39,000
Sept. 28, 1888 . . .	23,200	April 21, 1900 . . .	40,600
Nov. 30, 1888 . . .	30,400	May 21, 1900 . . .	20,500
Dec. 19, 1888 . . .	37,900	April 8, 1901 . . .	69,500
Jan. 11, 1889 . . .	24,600	May 21, 1901 . . .	31,700
March 8, 1889 . . .	23,600	Dec. 17, 1901 . . .	42,500
Nov. 30, 1889 . . .	24,300	Jan. 1, 1902 . . .	24,100
Dec. 11, 1889 . . .	24,100	March 4, 1902 . . .	60,600
Feb. 28, 1890 . . .	22,600	April 11, 1902 . . .	41,000
March 24, 1890 . . .	26,300	Oct. 30, 1902 . . .	28,000
April 16, 1890 . . .	27,100	Dec. 24, 1902 . . .	22,100
May 8, 1890 . . .	27,100	March 13, 1903 . . .	47,600
Sept. 19, 1890 . . .	25,300	June 23, 1903 . . .	39,100
Oct. 21, 1890 . . .	35,000	March 28, 1904 . . .	35,500
Jan. 26, 1891 . . .	21,300	April 30, 1904 . . .	49,900
Feb. 27, 1891 . . .	31,000	March 31, 1905 . . .	45,700
March 25, 1891 . . .	46,800	Sept. 5, 1905 . . .	21,700
April 14, 1891 . . .	36,000	Jan. 25, 1906 . . .	26,900
Jan. 16, 1892 . . .	27,700	April 17, 1906 . . .	39,900
May 24, 1892 . . .	30,400	May 30, 1906 . . .	43,200
Aug. 29, 1892 . . .	21,800	April 1, 1907 . . .	27,500
Nov. 18, 1892 . . .	25,100	Nov. 8, 1907 . . .	38,900
March 16, 1893 . . .	25,000	Dec. 12, 1907 . . .	26,600
April 15, 1893 . . .	22,000	Feb. 17, 1908 . . .	25,000
May 6, 1893 . . .	47,300	March 30, 1908 . . .	24,300

* Change in drainage area.

NOTE. — Except where marked P these figures are based upon the 11 A.M. reading at the Boott Mills.

MERRIMACK RIVER AT LOWELL, MASS. — *Concluded**Floods during Period of Daily Records — Concluded*

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
March 27, 1909 . .	26,000	Sept. 28, 1918 . .	20,500
April 16, 1909 . .	44,800	March 30, 1919 . .	44,400
March 3, 1910 . .	29,500	March 29, 1920 . .	51,800
April 28, 1910 . .	21,400	April 15, 1920 . .	39,400
March 31, 1911 . .	22,200	Oct. 2, 1920 . .	26,600
April 17, 1911 . .	21,400	Dec. 16, 1920 . .	43,900 P
March 31, 1912 . .	26,300	March 11, 1921 . .	32,600
April 9, 1912 . .	32,400	April 2, 1921 . .	22,600
March 29, 1913 . .	43,700	May 2, 1921 . .	22,100
March 4, 1914 . .	33,400	March 30, 1922 . .	33,900
April 3, 1914 . .	31,600	April 13, 1922 . .	44,200
May 1, 1914 . .	27,000	May 7, 1922 . .	36,400
Feb. 27, 1915 . .	41,100	June 23, 1922 . .	35,600
April 13, 1915 . .	21,800	July 1, 1922 . .	24,100
July 10, 1915 . .	35,600	April 7, 1923 . .	43,400
Aug. 6, 1915 . .	24,800	May 1, 1923 . .	57,800 P
Feb. 28, 1916 . .	26,400	Nov. 26, 1923 . .	28,100
April 3, 1916 . .	37,300	Dec. 8, 1923 . .	21,500
May 19, 1916 . .	37,600	April 8, 1924 . .	50,600 P
June 20, 1916 . .	26,900	April 21, 1924 . .	32,100 P
March 29, 1917 . .	34,500	May 3, 1924 . .	22,900 P
April 4, 1918 . .	27,500		

NOTE. — Except where marked P these figures are based upon the 11 A.M. reading at the Boott Mills.

NOTE. — Various diversions from areas tributary to the Merrimack River have been made to provide sources of water supply for Boston and the Metropolitan district; the first diversion, that from Lake Cochituate, was publicly celebrated in Boston on October 25, 1848. A temporary connection between Sudbury River and Lake Cochituate was made in 1872, and the permanent works for diversion of the Sudbury River supply were put into operation in 1878. The diversion from the South Branch of Nashua River became effective March 7, 1898, and has been the principal source of supply for Boston and the Metropolitan district since that date. Several minor changes have been made in the net areas diverted, and at times when the storage reservoirs are full water wastes back into the Merrimack River. The areas from which water is now diverted, except for occasional periods of waste, are as follows:

	Square Miles.
Lake Cochituate	17.58
Sudbury River	75.2
South Branch Nashua River	108.84
Total	201.62

Lake Winnepesaukee, tributary area above outlet 360 sq. mi.; Squam Lake, with tributary area above outlet 14.5 sq. mi.; Newfound Lake, tributary area 94 sq. mi., and several other smaller reservoirs are usually storing water at times of flood flow, so that the net effective areas above Lowell and Lawrence at times of floods would be less than the figures given for gross drainage areas.

MERRIMACK RIVER AT LAWRENCE, MASS.

(Drainage area, 4,664 sq. mi. (gross). See note.)

Source of data, Essex Company. Records furnished by Richard A. Hale.

Total length of period of daily records, 79 years, from 1846 to 1924.

Greatest known flood in 139 years 94,800 c. f. s.=20.3 c. f. s. per sq. mi. on April 23, 1852.

Second largest known flood 89,780 c. f. s.=19.3 c. f. s. per sq. mi. on April 21, 1870.

Third largest known flood 82,150 c. f. s.=18.0 c. f. s. per sq. mi. on March 3, 1896.

The greatest flood is known to be the maximum in at least 139 years.

Floods during Period of Daily Records

(Including only the "one-year floods" (average rate per 24 hours).)

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
March 15, 1846	71,250	Feb. 15, 1886	46,100
April 25, 1847	42,000	April 13, 1887	40,700
May 5, 1848	32,400	May 1, 1888	38,800
Nov. 11, 1849	56,850	Nov. 30, 1889	23,800
May 1, 1850	62,400	Oct. 21, 1890	31,450
Feb. 18, 1851	36,300	March 25, 1891	41,200
April 23, 1852	94,800	May 24, 1892	24,800
Feb. 8, 1853	53,400	May 6, 1893	44,800
May 2, 1854	60,510	March 9, 1894	27,900
April 21, 1855	52,900	April 16, 1895	65,300
April 11, 1856	34,650	March 3, 1896	82,150
April 16, 1857	56,620	July 16, 1897	41,499
Sept. 18, 1858	35,250	March 15, 1898	36,000
March 20, 1859	73,300	April 17, 1899	38,200
March 5, 1860	25,900	Feb. 15, 1900	52,989
April 16, 1861	50,600	April 9, 1901	62,511
April 21, 1862	70,790	March 4, 1902	61,185
April 20, 1863	54,850	March 13, 1903	45,469
March 8, 1864	63,500	May 1, 1904	46,336
March 18, 1865	63,500	March 30, 1905	45,940
Feb. 26, 1866	34,220	May 30, 1906	36,910
April 18, 1867	43,680	Nov. 8, 1907	32,330
May 25, 1868	49,500	Feb. 17, 1908	22,895
Oct. 6, 1869	70,790	April 17, 1909	34,929
April 21, 1870	89,780	March 3, 1910	28,420
March 14, 1871	34,780	March 31, 1911	20,918
April 12, 1872	46,370	April 9, 1912	30,720
April 12, 1873	44,140	March 29, 1913	37,040
Jan. 10, 1874	53,380	April 22, 1914	37,144
April 6, 1875	54,310	Feb. 27, 1915	39,200
March 30, 1876	52,530	May 19, 1916	32,883
March 29, 1877	66,570	March 29, 1917	31,116
Dec. 12, 1878	76,300	April 4, 1918	26,928
May 2, 1879	36,800	March 30, 1919	38,270
April 6, 1880	27,690	March 29, 1920	51,611
March 12, 1881	29,420	March 11, 1921	28,398
March 4, 1882	35,030	April 13, 1922	42,913
April 15, 1883	30,500	May 1, 1923	55,107
March 29, 1884	46,600	April 9, 1924	47,669
Nov. 11, 1885	24,720		

NOTE. — Figures show total flow as measured at Lawrence, with no allowance for effect of storage in Lake Winnepesaukee and other reservoirs.

SOUHEGAN RIVER AT MERRIMACK, N. H.

(Drainage area, 168 sq. mi.)

Records for 15 years, 1910 to 1924.

Greatest flood in above period, 7,120 c. f. s., April 8, 1924 (river at flood stage 3 days).

Second largest flood, 4,930 c. f. s., Aug. 5, 1915 (river at flood stage 2 days).

Third largest flood, 4,550 c. f. s., Dec. 15, 1920 (river at flood stage 2 days).

Lowest one-year flood, 1,830 c. f. s., March 26, 1918.

Floods during Period of Daily Records

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
March 1, 1910 . .	4,350 (a)	March 28, 1920 . .	3,530
March 28, 1911 . .	2,670 (a)	April 6, 1920 . .	2,140
April 7, 1911 . .	2,050 (a)	April 14, 1920 . .	2,100
March 16, 1912 . .	2,250 (a)	April 24, 1920 . .	1,930
March 30, 1912 . .	2,330 (a)	April 29, 1920 . .	1,900
March 28, 1913 . .	2,890 (a)	Oct. 1, 1920 . .	1,950
March 3, 1914 . .	3,350	Dec. 6, 1920 . .	2,770
March 28, 1914 . .	2,730 (a)	Dec. 15, 1920 . .	4,550
April 2, 1914 . .	2,030 (a)	March 10, 1921 . .	2,590
April 28, 1914 . .	2,470	May 1, 1921 . .	3,080
Feb. 26, 1915 . .	2,970 (a)	March 9, 1922 . .	2,060
July 9, 1915 . .	3,010	March 21, 1922 . .	1,880
Aug. 5, 1915 . .	4,930	March 28, 1922 . .	1,840
Feb. 27, 1916 . .	4,100	April 9, 1922 . .	1,920
April 2, 1916 . .	2,480	May 6, 1922 . .	3,570
April 24, 1916 . .	2,210	June 22, 1922 . .	2,590
May 18, 1916 . .	3,260	March 24, 1923 . .	2,300
March 28, 1917 . .	3,060	April 6, 1923 . .	3,170
June 18, 1917 . .	2,060	April 29, 1923 . .	3,010
March 26, 1918 . .	1,830	Nov. 25, 1923 . .	2,520
March 29, 1919 . .	2,990	Dec. 7, 1923 . .	2,160
May 23, 1919 . .	2,250	April 8, 1924 . .	7,120
March 14, 1920 . .	2,590		

NOTE. — On dates marked (a) the discharge corresponds to one reading of the gage on each day; all others are for peak stage.

CONNECTICUT RIVER AT ORFORD, N. H.

(Drainage area, 3,100 sq. mi.)

Records for 24 years, 1901 to 1924 (see note).

Greatest flood in above period, 57,200 c. f. s., March 28, 1913 (river at flood stage 11 days).

Second largest flood, 50,800 c. f. s., April 13, 1922 (river at flood stage 14 days).

Third largest flood, 49,700 c. f. s., April 16, 1909 (river at flood stage 11 days).

Lowest one-year flood, 23,600 c. f. s., May 19, 1904.

Floods during Period of Daily Records

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
April 9, 1901 . . .	31,900	Feb. 26, 1915 . . .	35,200 P
April 25, 1901 . . .	32,600	April 13, 1915 . . .	24,000 P
Dec. 17, 1901 . . .	28,400	April 3, 1916 . . .	31,700
March 3, 1902 . . .	43,400	March 29, 1917 . . .	26,500 P
May 29, 1902 . . .	31,900	April 3, 1917 . . .	28,900 P
March 12, 1903 . . .	33,400	April 24, 1917 . . .	29,500 P
March 24, 1903 . . .	40,100	June 13, 1917 . . .	23,600 P
May 19, 1904 . . .	23,600	June 19, 1917 . . .	28,000 P
March 30, 1905 . . .	37,200	Oct. 31, 1917 . . .	26,300 P
Jan. 25, 1906 . . .	27,100	April 3, 1918 . . .	29,900 P
April 17, 1906 . . .	30,200	Oct. 8, 1918 . . .	28,600 P
May 29, 1906 . . .	27,600	Nov. 1, 1918 . . .	29,100 P
March 31, 1907 . . .	27,000	March 29, 1919 . . .	27,600 P
May 3, 1907 . . .	40,600	April 14, 1919 . . .	29,600 P
Dec. 12, 1907 . . .	26,500	March 30, 1920 . . .	36,400 P
March 30, 1908 . . .	30,600	April 6, 1920 . . .	23,900 P
April 30, 1908 . . .	36,700	April 15, 1920 . . .	30,600 P
April 9, 1909 . . .	29,900	April 24, 1920 . . .	33,100 P
April 16, 1909 . . .	49,700	May 30, 1920 . . .	28,500 P
April 2, 1910 . . .	24,500	March 11, 1921 . . .	26,500 P
April 16, 1911 . . .	25,900	March 23, 1921 . . .	28,600 P
May 3, 1911 . . .	34,500	March 26, 1921 . . .	24,000 P
April 8, 1912 . . .	39,400 P	March 29, 1921 . . .	25,900 P
April 19, 1912 . . .	36,300 P	March 29, 1922 . . .	29,500 P
April 25, 1912 . . .	26,500 P	April 13, 1922 . . .	50,800 P
June 2, 1912 . . .	31,900 P	June 30, 1922 . . .	26,100 P
March 17, 1913 . . .	28,400 P	April 7, 1923 . . .	28,000 P
March 28, 1913 . . .	57,200 P	May 1, 1923 . . .	43,600 P
April 22, 1914 . . .	45,000 P	May 2, 1924 . . .	28,900 P
April 30, 1914 . . .	25,000 P	Sept. 13, 1924 . . .	32,200 P

NOTE. — Gage read once a day, except those marked P, which correspond to the higher of two or more readings. Records for 1923 and 1924 taken at South Newbury, Vt., drainage area, 2,830 sq. mi. No allowance made for water stored at Connecticut lakes.

CONNECTICUT RIVER AT WHITE RIVER JUNCTION, VT.

(Drainage area, 4,120 sq. mi.)

Records for 22 years, 1903 to 1924.

Greatest flood in above period, 88,500 c. f. s., April 12, 1922 (river at flood stage 14 days).

Second largest flood, 84,500 c. f. s., March 28, 1913 (river at flood stage 7 days).

Third largest flood, 69,600 c. f. s., April 8, 1912 (river at flood stage 4 days).

Lowest one-year flood, 31,600 c. f. s., April 2, 1910.

Floods during Period of Daily Records

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
March 24, 1903 . .	63,800	Nov. 1, 1917 . .	32,000
April 30, 1904 . .	32,400	April 3, 1918 . .	45,800
March 31, 1905 . .	61,000	Nov. 1, 1918 . .	31,600
April 16, 1906 . .	43,100	March 29, 1919 . .	41,400
April 27, 1907 . .	51,500	April 14, 1919 . .	35,300
April 30, 1908 . .	41,800	March 28, 1920 . .	39,200
April 16, 1909 . .	67,700	April 24, 1920 . .	48,000
April 2, 1910 . .	31,600	March 22, 1921 . .	39,600
April 30, 1911 . .	37,400	March 29, 1922 . .	45,300
April 8, 1912 . .	69,600	April 12, 1922 . .	88,500
March 28, 1913 . .	84,500	June 30, 1922 . .	32,800
April 21, 1914 . .	67,200	April 9, 1923 . .	45,800
Feb. 26, 1915 . .	42,700	May 1, 1923 . .	64,800
April 12, 1915 . .	32,800	April 20, 1924 . .	35,700
April 2, 1916 . .	40,500	May 2, 1924 . .	40,900
April 23, 1917 . .	39,200	Sept. 13, 1924 . .	37,000
June 19, 1917 . .	31,600		

NOTE. — For 1920 and subsequent years, the figures given correspond to the higher of two readings a day. Prior to 1920, gage was read but once a day, and no readings were taken from May 1 to October 31 during the years prior to 1912. Gage heights furnished by United States Weather Bureau and co-operating parties. Discharge computations made by United States Geological Survey. No allowance made for water stored at Connecticut lakes.

CONNECTICUT RIVER AT SUNDERLAND, MASS.

(Drainage area, 8,000 sq. mi.)

Records for 21 years, 1904 to 1924.

Greatest flood in above period, 108,000 c. f. s., March 28, 1913 (river at flood stage 9 days).

Second largest flood, 103,700 c. f. s., April 13, 1922 (river at flood stage 16 days).

Third largest flood, 97,000 c. f. s., March 28, 1920 (river at flood stage 14 days).

Lowest one-year flood, 59,300 c. f. s., April 16, 1911.

Floods during Period of Daily Records

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
April 30, 1904 . . .	70,600	Feb. 26, 1915 . . .	77,100
April 1, 1905 . . .	95,400	July 9, 1915 . . .	66,900
April 16, 1906 . . .	77,100	Jan. 29, 1916 . . .	61,700 (a)
May 29, 1906 . . .	69,300	April 3, 1916 . . .	74,900
March 31, 1907 . . .	60,900	March 30, 1917 . . .	63,700
April 28, 1907 . . .	63,300	April 23, 1917 . . .	60,300
Oct. 30, 1907 . . .	62,900	April 3, 1918 . . .	70,200
Nov. 8, 1907 . . .	74,300	March 29, 1919 . . .	78,200
Feb. 17, 1908 . . .	59,700 (a)	May 23, 1919 . . .	66,300
March 30, 1908 . . .	64,700	March 28, 1920 . . .	97,000
May 2, 1908 . . .	61,900	Dec. 16, 1920 . . .	64,300
April 16, 1909 . . .	96,200	March 10, 1921 . . .	76,500
March 2, 1910 . . .	85,800	March 30, 1922 . . .	78,000
April 16, 1911 . . .	59,300	April 13, 1922 . . .	103,700
April 9, 1912 . . .	84,500	April 7, 1923 . . .	85,000
March 28, 1913 . . .	108,000	April 30, 1923 . . .	76,300
April 3, 1914 . . .	64,100	April 7, 1924 . . .	60,900
April 10, 1914 . . .	60,300	April 20, 1924 . . .	59,700
April 21, 1914 . . .	90,000		

NOTE. — On dates marked (a) the discharge represents average for 24 hours; all others are for peak stage. No allowance made for effect of storage reservoirs.

CONNECTICUT RIVER AT HOLYOKE, MASS.

(Drainage area, 8,390 sq. mi.)

Records for 20 years, 1880 to 1899.

Greatest flood in above period, 115,000 c. f. s., April 16, 1895 (river at flood stage 15 days).

Second largest flood, 112,050 c. f. s., March 2, 1896 (river at flood stage 4 days).

Third largest flood, 99,750 c. f. s., May 1, 1888 (river at flood stage 22 days).

Lowest one-year flood, 37,800 c. f. s., April 22, 1889.

Floods during Period of Daily Records

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
March 6, 1880 . .	40,150	May 8, 1890 . .	46,750
April 6, 1880 . .	44,100	Oct. 20, 1890 . .	44,000
April 26, 1881 . .	48,500	March 25, 1891 . .	63,250
May 18, 1881 . .	49,050	April 16, 1891 . .	67,300
Dec. 30, 1881 . .	46,850	Jan. 15, 1892 . .	63,100
March 4, 1882 . .	43,650	April 5, 1892 . .	53,500
May 30, 1882 . .	38,500	May 24, 1892 . .	48,300
Sept. 24, 1882 . .	45,000	Nov. 17, 1892 . .	40,400
April 14, 1883 . .	68,300	April 15, 1893 . .	52,000
March 28, 1884 . .	71,900	May 5, 1893 . .	94,350
April 19, 1884 . .	70,800	April 25, 1894 . .	43,300
April 24, 1885 . .	63,950	April 16, 1895 . .	115,000
Nov. 10, 1885 . .	47,200	Jan. 1, 1896 . .	47,350
Jan. 6, 1886 . .	58,950	March 2, 1896 . .	112,050
April 2, 1886 . .	80,150	April 18, 1896 . .	89,200
Jan. 31, 1887 . .	39,150	April 18, 1897 . .	50,950
April 12, 1887 . .	85,500	June 11, 1897 . .	75,350
May 1, 1888 . .	99,750	July 16, 1897 . .	58,350
Sept. 22, 1888 . .	42,000	July 30, 1897 . .	53,650
Nov. 12, 1888 . .	38,050	Dec. 16, 1897 . .	70,650
Dec. 19, 1888 . .	59,300	March 21, 1898 . .	76,150
April 22, 1889 . .	37,800	April 26, 1898 . .	50,450
April 16, 1890 . .	46,250	April 26, 1899 . .	82,500

NOTE. — Discharge represents mean for 24 hours. Data furnished by the Holyoke Water Power Company, through A. F. Sickman, hydraulic engineer, and published in United States Geological Survey Water-Supply Paper 415.

WHITE RIVER AT WEST HARTFORD, VT.

(Drainage area, 687 sq. mi.)

Daily records for 9 years, 1916 to 1924, and miscellaneous data for earlier periods.

Greatest known flood in 21 years, 30,000 c. f. s., March 27, 1913.

Second largest known flood, 23,000* c. f. s., April 8, 1912.

Third largest known flood, 22,800 c. f. s., April 12, 1922 (river at flood stage 5 days).

Lowest known one-year flood, 9,980 c. f. s., April 2, 1918.

Floods during Period of Daily Records

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
April 2, 1916 . .	10,200	March 16, 1921 . .	12,100
June 12, 1917 . .	11,700	March 21, 1921 . .	15,000
April 2, 1918 . .	9,980	March 29, 1922 . .	16,300
March 28, 1919 . .	20,500	April 9, 1922 . .	10,600
March 25, 1920 . .	10,000	April 12, 1922 . .	22,800
April 13, 1920 . .	14,400	April 18, 1922 . .	14,000
April 16, 1920 . .	10,000	April 6, 1923 . .	15,200
April 22, 1920 . .	12,700	Dec. 1, 1923 . .	11,500
April 24, 1920 . .	10,000	Jan. 12, 1924 . .	10,000
Oct. 1, 1920 . .	10,300	April 14, 1924 . .	12,100
Dec. 15, 1920 . .	10,900	April 19, 1924 . .	12,300
March 10, 1921 . .	15,200	May 1, 1924 . .	11,500

* It is probable that a flood in 1909 exceeded 23,000 second-feet, but no record was obtained.

ASHUELOT RIVER AT HINSDALE, N. H.

(Drainage area, 440 sq. mi.)

Records for 15 years, 1907 to 1911 and 1915 to 1924.

Greatest flood in above period, 8,940 c. f. s., March 29, 1920 (river at flood stage 10 days).

Second largest flood, 5,250 c. f. s., April 7, 1923 (river at flood stage 6 days).

Third largest flood, 5,190 c. f. s., April 16, 1909 (river at flood stage 3 days).

Lowest one-year flood, 3,310 c. f. s., April 8, 1911.

Floods during Period of Daily Records

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
March 31, 1907 . .	3,350	Dec. 12, 1907 . .	3,570
Oct. 30, 1907 . .	3,570	Feb. 16, 1908 . .	4,560
Nov. 4, 1907 . .	3,350	March 30, 1908 . .	3,350
Nov. 8, 1907 . .	4,300	April 9, 1909 . .	3,500

NOTE. — Discharge corresponds to the higher of two readings a day.

ASHUELOT RIVER AT HINSDALE, N. H. — *Concluded**Floods during Period of Daily Records — Concluded*

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
April 16, 1909 . . .	5,190	March 29, 1920 . . .	8,940
Jan. 23, 1910 . . .	3,400	May 25, 1920 . . .	4,040
March 2, 1910 . . .	3,720	May 29, 1920 . . .	4,080
April 8, 1911 . . .	3,310	Dec. 7, 1920 . . .	3,350
Feb. 26, 1915 . . .	5,190	March 12, 1921 . . .	4,820
July 10, 1915 . . .	4,240	March 30, 1922 . . .	4,440
Aug. 5, 1915 . . .	3,720	April 13, 1922 . . .	4,620
Dec. 28, 1915 . . .	3,570	May 6, 1922 . . .	3,370
April 2, 1916 . . .	4,470	April 7, 1923 . . .	5,250
April 25, 1916 . . .	3,310	May 1, 1923 . . .	4,360
March 29, 1917 . . .	4,820	Nov. 26, 1923 . . .	4,070
April 3, 1918 . . .	4,180	Dec. 2, 1923 . . .	4,130
March 29, 1919 . . .	4,210	Dec. 7, 1923 . . .	3,550
May 24, 1919 . . .	4,330	April 9, 1924 . . .	4,890

NOTE. — Discharge corresponds to the higher of two readings a day.

MILLERS RIVER AT ERVING, MASS.

(Drainage area, 372 sq. mi.)

Records for 10 years, 1915 to 1924.

Greatest flood in above period, 5,800 c. f. s., March 28, 1920 (river at flood stage 13 days).

Second largest flood, 5,300 c. f. s., May 2, 1921 (river at flood stage 3 days).

Third largest flood, 5,270 c. f. s., April 8, 1924 (river at flood stage 5 days).

Lowest one-year flood, 3,090 c. f. s., April 3, 1918.

Floods during Period of Daily Records

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
Feb. 25, 1915 . . .	4,880	March 10, 1921 . . .	3,830
Aug. 4, 1915 . . .	3,870	May 2, 1921 . . .	5,300
April 2, 1916 . . .	3,830	March 8, 1922 . . .	3,290
March 28, 1917 . . .	4,820	March 30, 1922 . . .	3,400
April 3, 1918 . . .	3,090	April 12, 1922 . . .	3,360
March 28, 1919 . . .	3,760	May 6, 1922 . . .	3,400
May 23, 1919 . . .	3,780	June 22, 1922 . . .	4,850
March 28, 1920 . . .	5,800	June 30, 1922 . . .	3,260
April 14, 1920 . . .	3,810	April 7, 1923 . . .	5,050
April 29, 1920 . . .	3,950	April 30, 1923 . . .	4,320
Dec. 6, 1920 . . .	4,050	April 8, 1924 . . .	5,270
Dec. 15, 1920 . . .	3,980	April 20, 1924 . . .	3,260

NOTE. — Discharge represents peak stage.

DEERFIELD RIVER AT CHARLEMONT, MASS.

(Drainage area, 332 sq. mi. exclusive of 30 sq. mi. above Somerset reservoir.)

Records for 11 years, 1913 to 1923 (prior to construction of Davis Bridge reservoir); also records at Shelburne Falls (501 sq. mi.) beginning June 1, 1907.

Greatest flood in above period, 45,000 c. f. s., July 8, 1915 (river at flood stage 2 days).

Second largest flood, 33,000 c. f. s., March 27, 1913 (river at flood stage 3 days).

Third largest flood, 32,400 c. f. s., March 9, 1921 (river at flood stage 3 days).

Lowest one-year flood, 10,100 c. f. s., Jan. 28, 1916.

Floods during Period of Daily Records

DATE	Discharge, c. f. s. (Peak Stage)	Discharge, c. f. s. (Average for 24 Hours)
Nov. 7, 1907	—	16,300 (a)
March 29, 1908	—	10,600 (a)
April 15, 1909	—	21,300 (a)
Jan. 22, 1910	—	16,900 (a)
Oct. 19, 1911	—	11,100 (a)
Oct. 24, 1912	—	13,900 (a)
March 27, 1913	33,000	19,200 (a)
Nov. 9, 1913	24,700	11,000
March 28, 1914	12,700	9,340
April 20, 1914	18,200	15,700
April 11, 1915	11,900	9,350
July 8, 1915	45,000	12,200 (July 9)
Aug. 4, 1915	16,300	7,020
Dec. 26, 1915	11,500	4,880
Jan. 28, 1916	10,100	7,170
Oct. 30, 1917	13,900	5,400
March 22, 1918	15,300	4,450
March 28, 1919	27,500	14,000
May 22, 1919	21,200	13,700
March 26, 1920	13,600	8,950
April 13, 1920	18,400	8,000
Dec. 14, 1920	16,700	7,900 (Dec. 15)
March 9, 1921	32,400	14,800
March 21, 1921	10,700	8,250
April 1, 1921	10,700	6,500
May 1, 1921	11,700	7,170
March 29, 1922	12,500	11,300
April 12, 1922	21,000	12,600
May 19, 1922	11,400	8,430
June 11, 1922	14,900	4,000
April 29, 1923	14,900	9,900
Oct. 24, 1923	16,600	13,000

NOTE. — Discharge figures marked (a) represent mean for 24 hours at Shelburne Falls (501 sq. mi.); all other figures are for Charlemont (332 sq. mi. net).

WARE RIVER AT GIBBS CROSSING, MASS.

(Drainage area, 201 sq. mi.)

Records for 12 years, 1913 to 1924.

Greatest flood in above period, 2,950 c. f. s., April 8, 1924 (river at flood stage 6 days).

Second largest flood, 2,820 c. f. s., March 27, 1920 (river at flood stage 15 days); and 2,820 c. f. s., April 6, 1923 (river at flood stage 6 days).

Third largest flood, 2,770 c. f. s., March 2, 1914 (river at flood stage 6 days).

Lowest one-year flood, 1,320 c. f. s., Feb. 27, 1918.

Floods during Period of Daily Records

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
March 15, 1913 . .	1,440	April 29, 1920 . .	1,760
March 28, 1913 . .	2,640	Dec. 6, 1920 . .	2,130
April 13, 1913 . .	1,640	Dec. 15, 1920 . .	1,760
March 2, 1914 . .	2,770	March 10, 1921 . .	1,670
March 29, 1914 . .	1,950	April 18, 1921 . .	1,620
April 9, 1914 . .	1,580	May 1, 1921 . .	2,200
Jan. 19, 1915 . .	2,520	July 3, 1921 . .	1,800
Feb. 26, 1915 . .	2,560	March 8, 1922 . .	2,480
Aug. 5, 1915 . .	1,640	March 21, 1922 . .	1,580
Dec. 26, 1915 . .	1,330	April 9, 1922 . .	1,500
Feb. 27, 1916 . .	1,960	May 6, 1922 . .	1,480
March 31, 1916 . .	2,370	June 22, 1922 . .	1,500
July 28, 1916 . .	1,900	June 26, 1922 . .	1,480
Feb. 28, 1917 . .	2,200	June 30, 1922 . .	1,410
March 28, 1917 . .	2,430	July 5, 1922 . .	1,680
Feb. 27, 1918 . .	1,320	March 24, 1923 . .	2,340
March 2, 1919 . .	2,570	April 6, 1923 . .	2,820
March 29, 1919 . .	1,820	April 30, 1923 . .	2,270
May 23, 1919 . .	1,600	Jan. 12, 1924 . .	2,300
Nov. 28, 1919 . .	1,550	April 8, 1924 . .	2,950
March 18, 1920 . .	2,060	April 23, 1924 . .	1,500
March 27, 1920 . .	2,820		

NOTE. — Discharge represents peak stage.

SWIFT RIVER AT WEST WARE, MASS.

(Drainage area, 186 sq. mi.)

Records for 14 years, 1911 to 1924.

Greatest flood in above period, 2,390 c. f. s., April 7, 1923 (river at flood stage 8 days).

Second largest flood, 2,340 c. f. s., March 28, 1920 (river at flood stage 16 days).

Third largest flood, 2,280 c. f. s., May 2, 1921 (river at flood stage 5 days).

Lowest one-year flood, 1,100 c. f. s., March 25, 1918.

Floods during Period of Daily Records

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
March 31, 1911 . . .	1,350	April 15, 1920 . . .	1,320
March 18, 1912 . . .	1,810	April 29, 1920 . . .	1,200 (a)
March 31, 1912 . . .	1,640	Dec. 7, 1920 . . .	1,620
March 29, 1913 . . .	1,960	March 11, 1921 . . .	1,220
March 4, 1914 . . .	1,470	April 19, 1921 . . .	1,620
March 29, 1914 . . .	1,660	May 2, 1921 . . .	2,280
April 10, 1914 . . .	1,420	July 4, 1921 . . .	1,390
Jan. 20, 1915 . . .	1,250	March 8, 1922 . . .	1,340
Feb. 26, 1915 . . .	2,160	April 10, 1922 . . .	1,210
Aug. 5, 1915 . . .	2,010	July 1, 1922 . . .	1,960
Dec. 28, 1915 . . .	1,140	March 26, 1923 . . .	1,340
Feb. 27, 1916 . . .	1,200 (a)	April 7, 1923 . . .	2,390
April 3, 1916 . . .	1,970 (b)	May 1, 1923 . . .	1,960
March 29, 1917 . . .	1,800	Dec. 8, 1923 . . .	1,130
March 25, 1918 . . .	1,100	Jan. 13, 1924 . . .	1,230
March 30, 1919 . . .	1,350	Jan. 18, 1924 . . .	1,190
May 24, 1919 . . .	1,180	Jan. 27, 1924 . . .	1,440
March 28, 1920 . . .	2,340	April 9, 1924 . . .	1,820

NOTE. — On dates marked (a) the discharge represents average for 24 hours; all others are for peak stage. (b) Maximum peak due to failure of dam 1,000 feet above gage; natural peak was at discharge 1,770 c. f. s.

QUABOAG RIVER AT WEST BRIMFIELD, MASS.

(Drainage area, 150 sq. mi.)

Records for 15 years, 1910 to 1924.

Greatest flood in above period, 1,980 c. f. s., March 17, 1920 (river at flood stage 29 days); and 1,980 c. f. s., March 14, 1912.

Second largest flood, 1,750 c. f. s., April 7, 1924 (river at flood stage 9 days).

Third largest flood, 1,680 c. f. s., March 7, 1922 (river at flood stage 2 days).

Lowest one-year flood, 910 c. f. s., March 17, 1911.

Floods during Period of Daily Records

DATE	Discharge, c. f. s.
March 1, 1910 . . .	1,660 (Only one reading on this day).
March 17, 1911 . . .	910 (Only one reading between March 14 and March 21)
March 14, 1912 . . .	1,980 (From higher of two readings a day).
March 29, 1912 . . .	1,060 (From higher of two readings a day).
April 1, 1913 . . .	1,070
April 16, 1913 . . .	1,200
March 1, 1914 . . .	1,310
Jan. 7, 1915 . . .	1,660
Jan. 18, 1915 . . .	1,430
April 3, 1916 . . .	1,250
March 29 and 30, 1917 . . .	1,100
March 7, 1918 . . .	1,010
March 1, 1919 . . .	1,360
March 28, 1919 . . .	1,070
March 17, 1920 . . .	1,980
May 3, 1921 . . .	970
March 7, 1922 . . .	1,680
March 26, 1923 . . .	1,430
April 9, 1923 . . .	1,200
April 7, 1924 . . .	1,750

Peak stage from water-stage recorder for years 1913 to 1924.

WESTFIELD RIVER AT KNIGHTVILLE, MASS.

(Drainage area, 162 sq. mi.)

Records for 15 years, 1910 to 1924.

Greatest flood in above period, 10,500 c. f. s., April 7, 1924 (river at flood stage 1 day).

Second largest flood, 8,520 c. f. s., Aug. 4, 1915 (river at flood stage 2 days).

Third largest flood, 8,370 c. f. s., Jan. 22, 1910 (river at flood stage 3 days).

Lowest one-year flood, 1,940 c. f. s., April 2, 1918.

Floods during Period of Daily Records

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
Jan. 22, 1910 . . .	8,370	March 28, 1919 . . .	7,400
Feb. 28, 1910 . . .	3,180	May 18, 1919 . . .	2,700
March 5, 1910 . . .	2,360	May 22, 1919 . . .	8,070
March 26, 1910 . . .	2,280	Nov. 27, 1919 . . .	3,310
April 26, 1910 . . .	3,060	March 14, 1920 . . .	2,470
April 7, 1911 . . .	2,410	March 27, 1920 . . .	2,580
Oct. 19, 1911 . . .	3,710	April 3, 1920 . . .	2,010
March 15, 1912 . . .	7,700	April 6, 1920 . . .	2,300
March 29, 1912 . . .	2,580	April 13, 1920 . . .	7,740
April 18, 1912 . . .	2,050	April 23, 1920 . . .	2,160
Oct. 24, 1912 . . .	3,180	May 28, 1920 . . .	3,000
Jan. 8, 1913 . . .	2,440	June 18, 1920 . . .	3,000
Jan. 12, 1913 . . .	2,540	Oct. 1, 1920 . . .	4,870
March 14, 1913 . . .	2,980	Nov. 23, 1920 . . .	4,050
March 27, 1913 . . .	6,970	Dec. 5, 1920 . . .	4,740
March 31, 1913 . . .	2,590	Dec. 14, 1920 . . .	4,870
April 12, 1913 . . .	2,370	March 10, 1921 . . .	3,570
Oct. 26, 1913 . . .	2,060	March 13, 1921 . . .	2,720
Nov. 9, 1913 . . .	2,780	April 1, 1921 . . .	2,360
March 28, 1914 . . .	6,030	April 17, 1921 . . .	2,230
April 2, 1914 . . .	3,430	May 1, 1921 . . .	2,250
April 9, 1914 . . .	4,310	Dec. 18, 1921 . . .	2,360
April 19, 1914 . . .	2,190	March 8, 1922 . . .	2,900
May 13, 1914 . . .	2,360	March 29, 1922 . . .	3,060
Jan. 19, 1915 . . .	2,920	April 8, 1922 . . .	4,220
Feb. 25, 1915 . . .	6,750	April 12, 1922 . . .	3,570
April 12, 1915 . . .	2,680	April 15, 1922 . . .	2,470
July 8, 1915 . . .	6,800	May 5, 1922 . . .	3,310
July 20, 1915 . . .	2,030	May 19, 1922 . . .	5,150
Aug. 4, 1915 . . .	8,520	June 21, 1922 . . .	4,220
Dec. 26, 1915 . . .	2,940	March 24, 1923 . . .	2,100
Jan. 28, 1916 . . .	2,940	April 5, 1923 . . .	3,990
Feb. 26, 1916 . . .	3,880	April 29, 1923 . . .	3,270
April 2, 1916 . . .	2,650	Oct. 24, 1923 . . .	4,870
April 14, 1916 . . .	2,360	Dec. 6, 1923 . . .	3,540
March 28, 1917 . . .	3,340	Jan. 11, 1924 . . .	4,020
April 1, 1917 . . .	2,050	April 7, 1924 . . .	10,500
May 29, 1917 . . .	2,760	April 14, 1924 . . .	2,130
June 12, 1917 . . .	1,980	April 19, 1924 . . .	4,270
April 2, 1918 . . .	1,940	May 12, 1924 . . .	2,230
March 1, 1919 . . .	2,450	Sept. 10, 1924 . . .	2,360

NOTE. — Figures correspond to the higher of two readings a day.

WESTFIELD RIVER AT WESTFIELD, MASS.

(Drainage area, 496 sq. mi.)*

Records for 10 years, 1915 to 1924.

Greatest flood in above period, 24,500 c. f. s., April 7, 1924 (river at flood stage 2 days).

Second largest flood, 18,700 c. f. s., Feb. 25, 1915 (river at flood stage 1 day).

Third largest flood, 17,400 c. f. s., Aug. 4, 1915 (river at flood stage 2 days).

Lowest one-year flood, 6,180 c. f. s., March 23, 1918.

*Floods during Period of Daily Records.**

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
Feb. 25, 1915 . .	18,700	Dec. 5, 1920 . .	12,800
April 12, 1915 . .	8,550	Dec. 15, 1920 . .	15,200
July 9, 1915 . .	17,200	March 10, 1921 . .	14,100
Aug. 4, 1915 . .	17,400	March 8, 1922 . .	9,480
Dec. 26, 1915 . .	11,300	March 29, 1922 . .	8,060
April 1, 1916 . .	8,850	April 8, 1922 . .	8,200
March 28, 1917 . .	13,000	May 5, 1922 . .	11,200
Oct. 30, 1917 . .	7,900	May 19, 1922 . .	12,700
March 23, 1918 . .	6,180	June 21, 1922 . .	8,400
March 28, 1919 . .	15,600	March 24, 1923 . .	8,320
March 22, 1919 . .	17,400	April 6, 1923 . .	11,100
March 27, 1920 . .	8,550	April 29, 1923 . .	8,060
April 6, 1920 . .	9,580	Dec. 6, 1923 . .	8,170
April 13, 1920 . .	16,800	Jan. 11, 1924 . .	11,700
June 18, 1920 . .	8,520	April 7, 1924 . .	24,500
Oct. 1, 1920 . .	10,000	April 19, 1924 . .	10,500
Nov. 23, 1920 . .	13,100		

* No allowance made for diversion to Springfield water supply system.

NOTE. — No floods below 7,900 second feet are listed, except that for March 23, 1918. Discharge represents peak stage.

MIDDLE BRANCH OF WESTFIELD RIVER AT GOSS HEIGHTS, MASS.

(Drainage area, 53 sq. mi.)

Records for 14 years, 1911 to 1924.

Greatest flood in above period, 4,500 c. f. s., July 8, 1915 (river at flood stage 2 days).

Second largest flood, 4,230 c. f. s., April 13, 1920 (river at flood stage 1 day).

Third largest flood, 3,870 c. f. s., Aug. 4, 1915 (river at flood stage 1 day).

Lowest one-year flood, 1,220 c. f. s., March 22, 1918.

Floods during Period of Daily Records

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
March 27, 1911 . . .	2,120	Nov. 27, 1919 . . .	1,390
April 6, 1911 . . .	1,410	March 27, 1920 . . .	1,470
Oct. 19, 1911 . . .	1,760	April 5, 1920 . . .	1,950
March 16, 1912 . . .	1,900	April 13, 1920 . . .	4,230
March 27, 1913 . . .	2,600	June 18, 1920 . . .	1,420
April 12, 1913 . . .	1,370	Oct. 1, 1920 . . .	2,180
Oct. 26, 1913 . . .	1,730	Nov. 23, 1920 . . .	2,420
Nov. 9, 1913 . . .	2,290	Dec. 5, 1920 . . .	2,200
March 28, 1914 . . .	2,330	Dec. 15, 1920 . . .	2,240
April 2, 1914 . . .	1,240	Mar. 9, 1921 . . .	3,650
April 9, 1914 . . .	2,560	March 29, 1922 . . .	1,260
Jan. 18, 1915 . . .	1,650	April 8, 1922 . . .	1,380
Feb. 25, 1915 . . .	2,680	May 5, 1922 . . .	1,940
April 12, 1915 . . .	1,500	May 19, 1922 . . .	2,650
July 8, 1915 . . .	4,500	June 21, 1922 . . .	1,870
Aug. 4, 1915 . . .	3,870	April 5, 1923 . . .	2,010
Dec. 26, 1915 . . .	2,900	April 29, 1923 . . .	1,370
April 1, 1916 . . .	1,470	Oct. 24, 1923 . . .	1,760
April 14, 1916 . . .	1,370	Nov. 30, 1923 . . .	1,520
April 1, 1917 . . .	1,330	Dec. 6, 1923 . . .	1,560
May 29, 1917 . . .	1,250	Jan. 11, 1924 . . .	2,200
Oct. 30, 1917 . . .	1,220	April 7, 1924 . . .	2,270
March 22, 1918 . . .	1,220	April 19, 1924 . . .	2,000
March 28, 1919 . . .	3,350	Sept. 10, 1924 . . .	1,380
May 22, 1919 . . .	3,110		

NOTE. — Discharge represents peak stage.

FARMINGTON RIVER NEAR NEW BOSTON, MASS.

(Drainage area, 92.7 sq. mi.)*

Records for 11 years, 1914 to 1924.

Greatest flood in above period, 3,450 c. f. s., April 7, 1924 (river at flood stage 2 days).

Second largest flood, 3,200 c. f. s., Oct. 26, 1913 (river at flood stage 2 days).

Third largest flood, 2,600 c. f. s., Feb. 25, 1915 (river at flood stage 1 day).

Lowest one-year flood, 1,010 c. f. s., March 22, 1918.

*Floods during Period of Daily Records.**

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
Oct. 26, 1913 . . .	3,200	April 13, 1920 . . .	2,390
Nov. 9, 1913 . . .	1,290	June 18, 1920 . . .	1,200
March 28, 1914 . . .	2,150	Aug. 16, 1920 . . .	1,960
April 2, 1914 . . .	1,080	Oct. 1, 1920 . . .	2,320
April 8, 1914 . . .	2,080	Nov. 23, 1920 . . .	2,030
Jan. 7, 1915 . . .	2,350	Dec. 5, 1920 . . .	2,200
Jan. 13, 1915 . . .	1,520	Dec. 14, 1920 . . .	2,240
Jan. 18, 1915 . . .	1,420	March 9, 1921 . . .	2,520
Feb. 25, 1915 . . .	2,600	March 13, 1921 . . .	1,310
April 12, 1915 . . .	1,540	April 17, 1921 . . .	1,320
July 8, 1915 . . .	1,910	March 7, 1922 . . .	1,760
Aug. 4, 1915 . . .	2,180	March 29, 1922 . . .	2,200
Dec. 26, 1915 . . .	2,120	April 8, 1922 . . .	1,450
Jan. 28, 1916 . . .	1,280	May 5, 1922 . . .	1,720
April 1, 1916 . . .	1,590	May 19, 1922 . . .	1,230
April 14, 1916 . . .	1,240	June 21, 1922 . . .	1,080
Jan. 14, 1917 . . .	1,800	March 23, 1923 . . .	1,150
March 27, 1917 . . .	1,900	April 5, 1923 . . .	1,800
April 1, 1917 . . .	1,360	April 29, 1923 . . .	1,450
March 22, 1918 . . .	1,010	Oct. 24, 1923 . . .	1,720
March 1, 1919 . . .	1,230	Jan. 11, 1924 . . .	2,110
March 28, 1919 . . .	2,540	Jan. 17, 1924 . . .	1,160
May 17, 1919 . . .	1,040	April 7, 1924 . . .	3,450
May 22, 1919 . . .	2,240	April 19, 1924 . . .	1,640
April 5, 1920 . . .	1,630	May 12, 1924 . . .	1,170

* No allowance made for storage in Otis Reservoir. Otis Reservoir controls an area of 17.6 sq. mi. and it is probable that the gates were closed at times of flood flow.

NOTE. — Discharge represents peak stage.

HOUSATONIC RIVER NEAR GREAT BARRINGTON, MASS.

(Drainage area, 280 sq. mi.)

Records for 11 years, 1914 to 1924.

(For greatest floods, 1901-24, see also data for Housatonic River at Gaylordsville, Conn.)

Floods during Period of Daily Records

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
March 29, 1914 . .	5,220	April 3, 1920 . .	4,450
April 3, 1914 . .	3,460	April 15, 1920 . .	3,910
April 10, 1914 . .	4,500	April 25, 1920 . .	3,280
April 17, 1914 . .	4,200	Oct. 1, 1920 . .	2,780
April 21, 1914 . .	3,320	Dec. 7, 1920 . .	3,320
Feb. 16, 1915 . .	2,510	Dec. 16, 1920 . .	2,870
Feb. 26, 1915 . .	3,850	March 10, 1921 . .	4,800
July 9, 1915 . .	4,100	March 8, 1922 . .	3,180
Dec. 26, 1915 . .	3,800	March 29, 1922 . .	3,900
Jan. 28, 1916 . .	3,320	April 10, 1922 . .	3,000
March 31, 1916 . .	5,300	May 20, 1922 . .	2,870
April 15, 1916 . .	2,960	March 24, 1923 . .	2,650
March 28, 1917 . .	4,200	April 6, 1923 . .	4,650
April 2, 1917 . .	2,780	Oct. 25, 1923 . .	2,880
March 23, 1918 . .	2,670	April 7, 1924 . .	4,900
May 23, 1919 . .	2,490	April 19, 1924 . .	2,830
March 18, 1920 . .	2,490		

NOTE. — Discharge represents peak stage.

HOUSATONIC RIVER AT FALLS VILLAGE, CONN.

(Drainage area, 644 sq. mi.)

Records for 12 years, 1913 to 1924.

(For greatest floods, 1901-24, see also data for Housatonic River at Gaylordsville, Conn.)

Floods during Period of Daily Records

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
March 29, 1913 . .	8,110 (a)	Feb. 26, 1915 . .	5,850 (a)
April 14, 1913 . .	4,240 (a)	July 10, 1915 . .	4,480 (a)
Oct. 27, 1913 . .	4,510 (a)	Dec. 28, 1915 . .	5,670 (a)
March 29, 1914 . .	8,830	Jan. 29, 1916 . .	4,770 (a)
April 10, 1914 . .	5,680 (a)	April 3, 1916 . .	6,960
April 22, 1914 . .	4,280 (a)	April 16, 1916 . .	4,360 (a)

NOTE. — On dates marked (a) the discharge represents average for 24 hours; all others are for peak stage.

HOUSATONIC RIVER AT FALLS VILLAGE, CONN. — *Concluded.**Floods during Period of Daily Records — Concluded*

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
March 29, 1917 . . .	6,000	March 9, 1922 . . .	5,230
April 3, 1917 . . .	4,340	March 31, 1922 . . .	4,840
March 23, 1918 . . .	4,220	April 10, 1922 . . .	4,300
March 28, 1919 . . .	4,320	March 25, 1923 . . .	5,460
March 29, 1920 . . .	7,950	April 6, 1923 . . .	5,570
April 15, 1920 . . .	5,380	Jan. 12, 1924 . . .	4,330
Oct. 2, 1920 . . .	4,960	April 7, 1924 . . .	8,390
Dec. 8, 1920 . . .	4,460	April 20, 1924 . . .	4,240
March 11, 1921 . . .	5,490		

NOTE. — On dates marked (a) the discharge represents average for 24 hours; all others are for peak stage.

HOUSATONIC RIVER AT GAYLORDSVILLE, CONN.

(Drainage area, 1,020 sq. mi.)

Records for 14 years, 1901 to 1914.

Greatest flood in above period, 31,000 c. f. s., March 1, 1902 (river at flood stage 4 days).

Second largest flood, 25,700 c. f. s., Feb. 21, 1903 (river at flood stage 5 days).

Third largest flood, 20,300 c. f. s., Jan. 22, 1910 (river at flood stage 2 days).

Lowest one-year flood, 8,800 c. f. s., March 30, 1911.

Floods during Period of Daily Records

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
March 11, 1901 . . .	9,340	Jan. 7, 1905 . . .	13,700 P
March 21, 1901 . . .	17,900 P	March 27, 1905 . . .	12,100 P
April 8, 1901 . . .	9,610	March 4, 1906 . . .	10,400 P
April 22, 1901 . . .	12,400	April 16, 1906 . . .	9,100 P
Dec. 15, 1901 . . .	11,200	Oct. 30, 1907 . . .	17,300 P
Dec. 30, 1901 . . .	12,600	Nov. 8, 1907 . . .	8,800
Jan. 22, 1902 . . .	10,200	Feb. 16, 1908 . . .	12,900
March 1, 1902 . . .	31,000	Feb. 20, 1909 . . .	10,400
March 14, 1902 . . .	8,800	April 15, 1909 . . .	8,930
Dec. 17, 1902 . . .	8,800 P	Jan. 22, 1910 . . .	20,300 P
Dec. 22, 1902 . . .	11,000 P	March 2, 1910 . . .	13,500 P
Feb. 21, 1903 . . .	25,700 P	March 30, 1911 . . .	8,800 P
March 1, 1903 . . .	12,400 P	Feb. 22, 1912 . . .	11,500
March 24, 1903 . . .	11,000 P	March 13, 1912 . . .	11,000 P
June 22, 1903 . . .	10,200 P	March 16, 1912 . . .	12,100 P
Oct. 9, 1903 . . .	12,900 P	March 27, 1913 . . .	14,000 P
Dec. 21, 1903 . . .	9,340 P	March 29, 1914 . . .	14,900
March 8, 1904 . . .	12,600 P	April 11, 1914 . . .	8,800

NOTE. — Discharge figures are for one reading a day, except those marked P, which correspond to the higher of two or more readings.

WINOOSKI RIVER AT MONTPELIER, VT.

(Drainage area, 420 sq. mi.)

Records for 14 years, 1910 to 1923.

Greatest flood in above period, 20,200 c. f. s., April 7, 1912 (river at flood stage 2 days).

Second largest flood, 15,500 c. f. s., April 12, 1922 (river at flood stage 4 days).

Third largest flood, 15,000 c. f. s., March 28, 1919 (river at flood stage 1 day).

Lowest one-year flood, 5,420 c. f. s., April 7, 1911.

Floods during Period of Daily Records

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
March 3, 1910 . . .	5,540 C	Oct. 31, 1918 . . .	8,550 P
April 7, 1911 . . .	5,420 C	Nov. 19, 1918 . . .	5,480 P
April 7, 1912 . . .	20,200 H	March 28, 1919 . . .	15,000 P
April 16, 1912 . . .	7,900 B	April 12, 1919 . . .	8,400 P
May 21, 1912 . . .	5,440 B	March 26, 1920 . . .	13,900 P
May 31, 1912 . . .	6,640 B	April 13, 1920 . . .	10,500 P
Oct. 24, 1912 . . .	6,790 B	April 24, 1920 . . .	5,450 P
March 14, 1913 . . .	8,180 B	Oct. 1, 1920 . . .	13,000 P
March 22, 1913 . . .	5,700 B	Dec. 15, 1920 . . .	6,630 P
March 27, 1913 . . .	15,000 H	March 10, 1921 . . .	8,340 P
April 20, 1914 . . .	10,600 B	March 16, 1921 . . .	7,010 P
April 12, 1915 . . .	9,000 P	March 21, 1921 . . .	8,360 P
Jan. 28, 1916 . . .	5,790 A	March 8, 1922 . . .	7,820 P
April 2, 1916 . . .	6,630 P	March 15, 1922 . . .	8,310 P
March 28, 1917 . . .	10,600 P	March 29, 1922 . . .	7,890 P
June 12, 1917 . . .	6,140 A	April 12, 1922 . . .	15,500 P
Oct. 30, 1917 . . .	8,780 P	April 6, 1923 . . .	11,100 P
April 2, 1918 . . .	5,950 A	April 30, 1923 . . .	8,750 P
Oct. 6, 1918 . . .	9,070 P		

NOTE.—Flood stages determined as follows: A, average rate for 24 hours; B, higher of two readings; C, one reading; P, peak rate from water-stage recorder; H, from high-water mark.

DATE	MAXIMUM DISCHARGE		Remarks
	c. f. s.	c. f. s. per Square Mile	
March 8, 1903 . . .	23,600 (app.)	21.85	Winooski River near Winooski, Vt.
March 26, 1904 . . .	31,000 (app.)	31.47	Winooski River at Richmond, Vt.
March 30, 1905 . . .	16,100 (app.)	16.34	Winooski River at Richmond, Vt.
Jan. 24, 1906 . . .	21,200 (app.)	21.52	Winooski River at Richmond, Vt.
April 16, 1906 . . .	15,800 (app.)	16.04	Winooski River at Richmond, Vt.
March 31, 1907 . . .	16,000 (app.)	16.24	Winooski River at Richmond, Vt.
Feb. 15, 1908 . . .	18,900 (app.)	45.00	Winooski River at Montpelier.
April 14, 1909 . . .	15,900 (app.)	37.86	Winooski River at Montpelier.

LAMOILLE RIVER AT CADYS FALLS, VT.

(Drainage area, 280 sq. mi.)

Daily records for 10 years, 1914 to 1923, and miscellaneous data for earlier periods.

Greatest known flood in 12 years, 11,700* c. f. s., April 8, 1912.

Second largest known flood, 8,730 c. f. s., Oct. 1, 1920 (river at flood stage 1 day).

Third largest known flood, 7,530 c. f. s., April 12, 1919 (river at flood stage 1 day).

Lowest known one-year flood, 3,370 c. f. s., April 2, 1916.

Floods during Period of Daily Records

DATE	Discharge, c. f. s.	DATE.	Discharge, c. f. s.
April 20, 1914 . .	7,250	April 6, 1920 . .	3,750
Feb. 25, 1915 . .	6,500	April 13, 1920 . .	6,160
April 11, 1915 . .	6,500	April 24, 1920 . .	4,090
April 2, 1916 . .	3,370	Oct. 1, 1920 . .	8,730
March 29, 1917 . .	3,620 (a)	Dec. 5, 1920 . .	3,630
April 2, 1917 . .	3,420 (a)	Dec. 15, 1920 . .	4,200
April 21, 1917 . .	3,620 (a)	March 9, 1921 . .	4,880
June 12, 1917 . .	3,420 (a)	March 16, 1921 . .	4,240
Oct. 30, 1917 . .	7,430	March 21, 1921 . .	5,310
April 2, 1918 . .	4,550 (a)	March 8, 1922 . .	3,900
Oct. 6, 1918 . .	6,400	March 29, 1922 . .	4,000
Oct. 31, 1918 . .	6,570	April 12, 1922 . .	7,360
March 28, 1919 . .	4,380	June 18, 1922 . .	3,480
April 12, 1919 . .	7,530	June 22, 1922 . .	3,790
Oct. 11, 1919 . .	3,950	April 6, 1923 . .	4,260
Oct. 31, 1919 . .	3,510	April 23, 1923 . .	5,090
March 27, 1920 . .	5,150	April 30, 1923 . .	5,820

* Records for 1912 taken at Johnson, Vt., drainage area, 324 sq. mi.

NOTE. — On dates marked (a) the discharge represents average for 24 hours; all others are for peak stage.

MISSISSQUOI RIVER NEAR RICHFORD, VT.

(Drainage area, 445 sq. mi.)

Records for 12 years, 1912 to 1923.

Greatest flood in above period, 13,000 c. f. s., April 7, 1923 (river at flood stage 4 days).

Second largest flood, 11,700 c. f. s., April 8, 1912 (river at flood stage 3 days).

Third largest flood, 10,200 c. f. s., March 26, 1913 (river at flood stage 5 days).

Lowest one-year flood, 5,500 c. f. s., April 13, 1915.

Floods during Period of Daily Records

DATE	Discharge, c. f. s.	DATE	Discharge, c. f. s.
April 8, 1912 . . .	11,700 (t)	April 7, 1919 . . .	6,180
April 17, 1912 . . .	8,450 (t)	April 12, 1919 . . .	9,380
April 23, 1912 . . .	8,100 (t)	Oct. 31, 1919 . . .	8,210
June 1, 1912 . . .	8,200 (o)	Nov. 13, 1919 . . .	5,540
Nov. 8, 1912 . . .	5,550 (t)	March 13, 1920 . . .	6,800
Dec. 20, 1912 . . .	5,750 (o)	March 17, 1920 . . .	5,950
March 26, 1913 . . .	10,200 (o)	Oct. 1, 1920 . . .	8,170
April 20, 1914 . . .	9,600 (t)	Dec. 5, 1920 . . .	6,380
April 13, 1915 . . .	5,500 (t)	Dec. 15, 1920 . . .	6,350
April 1, 1916 . . .	7,460 (a)	Nov. 20, 1921 . . .	6,120
March 28, 1917 . . .	5,600 (a)	March 29, 1922 . . .	6,720
April 3, 1917 . . .	8,690	April 12, 1922 . . .	9,510
April 22, 1917 . . .	6,240 (a)	June 18, 1922 . . .	8,910
June 12, 1917 . . .	6,120 (a)	June 23, 1922 . . .	6,700
Oct. 31, 1917 . . .	6,720 (a)	June 29, 1922 . . .	5,640
April 2, 1918 . . .	9,000 (a)	April 7, 1923 . . .	13,000
Oct. 6, 1918 . . .	9,240	April 22, 1923 . . .	8,610
Oct. 31, 1918 . . .	8,460	April 30, 1923 . . .	9,170
March 20, 1919 . . .	8,650		

NOTE. — On dates marked (t) the discharge corresponds to the higher of two readings a day; on dates marked (o) to one reading a day; on dates marked (a) to average for 24 hours; all others are for peak stage. No records were obtained March 20 to June 24, 1920, and March 8 to June 13, 1921.

PRINCIPAL FLOODS OF THE CONNECTICUT RIVER, 1639-1924

(From data compiled by the late Arthur Watson of Northampton, Mass., and made available by J. L. Harrison, Librarian, Forbes Library,* Northampton.)

From the Matthew Grant, Windsor Church Records (original manuscripts at Connecticut Historical Society), it is learned that, "the great flood of 1639 began the 5th of March. On the 11th it began to fall, but by reason of much rain on the 12th day it rose very high. On the 15th and 16th the flood had fallen near two feet, but on the 16th day was much rain and great wind out of the southeast which made it an exceeding great storm. It indamaged houses and break down many trees so that by the casue of which rain all the 17th and 18th days the water rose very high, more than had ever been known by the Indians. On the 18th day at night there was a great feat of another storm of wind and rain. It began, but it pleased the Lord, it ceased quickly and by morning one might perceive the water was begun to fall and so it continued. On the 22nd day at night, it was well fallen and yet it was as high as the highest flood we had known before."

In Massachusetts Collections, 4th Series, vol. 8, there is a letter from John Haynes to John Winthrop, dated Wethersfield, 27th first month, *i.e.*, March 27. "Wee have lately hadd great floods that cam upp to some of our howses, and carryed away a good parte of our fences in our lowe grounds. Otherwise, wee blesse the Lord, we are generally in good health."

The flood of 1692 was the result of rain that fell almost continuously for five days. The diary of Capt. Lawrence Hammond of Boston and Charlestown refers to this flood as follows: "February 23, 1692, Rain in ye nite and continued all ye week, more or less to rain wth much wind, betw ye S. E. & N. E. 28th likewise much rain and wind, som raine ye 29 also. March 1, wind at N. W. & cleare weather. These rains wth ye violent sudden melting of ye snow in ye wilderness caused much a sudden & violent flood yt hath done abundance of damage in most parts of ye country. Carrying away bridges, mills, etc. Connecticut River 3 feet higher yn ever it was known before, destroyed mch cattel in ye meadows, carryed away som Houses & washed away in many places ye very land wth ye English graine sown it it".

The next extraordinary flood of which we have record occurred in March, 1801, being the result of a three-day heavy rain, causing "streams to rise to unexampled height, and resulting in an immediate inundation and destruction of property."

"1854, May 3, Messrs. Editors, Springfield Republican. Having lived within 200 rods of the Conn. River since 1799 and during that time having paid some attention to the floods of the river, I note as the first that of 1801,

* Descriptions of early floods of the Connecticut River and a large amount of data relating to Connecticut River floods were collected by Mr. Watson and are now in the Forbes Library, Northampton, Mass. W. W. Neifert, Meteorologist, United States Weather Bureau, furnished a considerable part of the data.

known here as the 'Jefferson Flood'. The next in magnitude was the flood of 1843 in connection with which there was some controversy as to the relative height of the two. By my observation that of 1843 fell between 6 and 7 inches short of the flood of 1801. When that of 1843 occurred we determined to silence all cavil in future in this vicinity and we accordingly erected a stone monument on a stone foundation below the frost with the year, month, and day of the month, cut into same, and above all a line marked "waterline". The flood of the present year which we will christen the 'Hoosac Tunnel Flood' (events long to be remembered by the good people of Mass.) exceeds that of 1801, at least a foot and that of 1843, 1 ft. & $6\frac{1}{2}$ inches, at the location where these notes were taken in the south part of West Springfield. Whether the dam at Windsor Locks has any effect here we are unable to say, perhaps it may. But as to the relative height of the last named floods, that statement is correct as many can testify as the mark was visible by numbers every half hour during the day and evening of Sunday last while the water was rising and further my own and my neighbors fields which were above water in the flood of 1801 were now submerged on level ground 1 foot or more. Yours,

THREE SCORE AND THIRTEEN".

The greatest flood within authentic record at Hartford was in May, 1854, with a gage reading of 29.8 feet. This was at a period when all the forests of the upper watershed were still intact. It was, however, not a remarkable flood in the Merrimack, the only other New England river for which dependable records for that time are available. This was due to the prevalence of heavy rain, which began on the evening of April 27 and continued, practically without intermission, until noon of May 1, a period of about ninety hours. There is some evidence showing that a week prior to the rain a foot of wet snow fell over the upper watershed, and it is possible that there was still some of the winter's snow on the north slopes in New Hampshire and Vermont at the beginning of the warm spell that immediately preceded the heavy rain which deposited nearly seven inches at Hartford. That the "oldest inhabitant" existed at that time, is evidenced by the following extract from The Hartford Times:

"The 'oldest inhabitant' can no longer crow. The great flood of 1801 which has so long formed the standing proof of the greatness of the past and the degeneracy of the present age, and which few expected to see equalled during the present century, has been beaten hollow in this year of our Lord, 1854. For three days and three nights the celestial water gates have been thrown open and we have had a perfect Noachian deluge as the result. Aquarius has ruled the roost and if water had been the universal solvent which the ancient philosophers declared it to be, there would have been nothing left of this drenched and drowned town. No man living has seen so great a fall of water from one storm in these parts. Hence forward 1801 must hide his diminished head and 1854 be duly installed as the cock — not of the walk — but of the century in the water line."

The flood of April, 1862, was due wholly to melting snow and the breaking up of ice in the streams. There was only relatively light rain throughout the valley before the flood, but the day temperatures were above sixty degrees for nearly a week prior to the high water.

Little is known of the flood of August, 1856, except that through the weather reports made to the Smithsonian Institution at the time we learn that it was caused by heavy rains throughout the valley of the Connecticut. Probably the greatest of all summer floods in this valley was the so-called "pumpkin flood", in October, 1869. This remarkable visitation ranks among the half dozen large floods in New England during the past eighty years, and came at a season of the year when the streams are usually at a low stage. It was caused by a "northeaster" of great vigor that swept the states from Florida to the St. Lawrence Valley, with the greatest fall of rain directly over the Connecticut Valley and its tributary streams. The heaviest rain was over the lower reaches, the amount measured at Hartford being slightly over eight inches. Great damage resulted to the farmers along the valley, as all crops were not yet harvested. It is reported that the flood removed every pumpkin from the fields along the river banks as far as it reached, and old residents say that the stream was jammed full of pumpkins from Deerfield south. These heavy summer rains are due to an unusually rare combination of atmospheric conditions that occur perhaps two or three times in a century, and suggest that the probability of a summer flood cannot be eliminated; however, the occurrence is not frequent.

The floods of 1895 and 1896 were due in both cases to heavy and continued rains at a time when the snow was sufficient, when reduced to water, to greatly intensify the freshet conditions. The high water of 1913 — which we all remember — was entirely a heavy rain flood. The mild rainy weather of March 20 to 22 reduced to water the snow and ice yet remaining in the woods and mountains, and there being considerable frost in the ground conditions were favorable for a rapid run-off. Hence the smaller streams soon filled to overflowing banks, and were augmented by heavy rains two days later (falling on thoroughly saturated ground where not frozen). A sharp rise in the larger streams quickly followed. In addition, these larger streams were still running relatively high in connection with freshet conditions of the previous week. An immense volume of water was soon sweeping down from the north with irresistible force, inundating thousands of acres of land, and doing damage of such extent that the total value could not be estimated in a monetary sense. It produced at Hartford the highest water since 1896, and in the upper valley, where the rainfall was the heaviest, the greatest flood since 1869. It is further claimed by elderly people in upper Vermont that the crest wave was even higher than during the 1854 flood.

Comparative Heights of Principal Floods of the Connecticut River, 1639-1924.

DATE		RIVER STAGES (IN FEET)			Peak Dis- charge at Sunderland, Mass. (Cubic Feet per Second)
Year	Month	Hartford, Conn.	Springfield, Mass.	Holyoke, Mass.	
1639	Mar. 18 . . .	"Great flood"	—	—	—
1642	May-June . . .	"Great flood"	—	—	—
1683	July-Aug. . . .	26.0	—	—	—
1692	Feb.-Mar. . . .	26.2	—	—	—
1767	Jan. 12	"Great flood"	—	—	—
1793	Feb. 21	"Great flood"	—	—	—
1798	Mar. 25	"Great flood"	—	—	—
1801	Mar. 20	27.5	21.2	"Jefferson flood"	—
1807	Feb. 1	"Great flood"	—	—	—
1818	Mar. 3	"Great flood"	—	—	—
1824	Feb. 24	"Great flood"	—	—	—
1827	Mar. 30	"Great flood"	—	—	—
1838	Jan. 28	23.0	—	—	—
1839	Jan. 29	24.2	—	—	—
1841	Jan. 9	26.3	—	—	—
1843	Mar. 29	27.2	20.7	—	—
1852	Apr. 24	23.2	19.5	—	—
1854	May 1	29.8	22.2	—	—
1856	Aug. 21-22 . . .	23.3	18.9	—	—
1859	Mar. 19-20 . . .	26.4	20.5	—	—
1862	Apr. 20-21 . . .	28.7	22.0	—	—
1865	Mar. 18-20 . . .	24.8	18.0	—	—
1869	Apr. 22-23 . . .	26.7	20.5	11.2	—
1869	Oct. 5-6	26.3	21.0	12.7	—
1870	Apr. 20-21 . . .	25.3	19.0	9.5	—
1874	Jan. 9	23.9	17.5	8.0	—
1878	Dec. 11-13 . . .	24.5	18.5	9.2	—
1893	May 5-6	24.0	18.1	8.4	—
1895	Apr. 16-17 . . .	25.7	20.2	9.6	—
1896	Mar. 2-3	26.5	20.2	9.5	—
1900	Feb. 14-15 . . .	23.4	17.0	—	—
1901	Apr. 8-10	25.8	19.7	11.4	—
1902	Mar. 4	25.3	19.2	10.8	—
1903	Mar. 24-25 . . .	23.4	17.4	10.6	—
1904	Apr. 30	21.4	—	—	70,600
1905	Mar. 31-Apr. 2 . .	24.0	17.5	10.6	95,400
1906	May 29-30	18.5	—	—	69,300
1907	Nov. 8-9	20.3	15.4	9.0	74,300
1908	Mar. 30-31	18.2	13.1	7.6	64,700
1909	Apr. 16-17	24.7	18.5	10.6	96,200
1910	Jan. 23	20.0	15.0	7.5	57,300

NOTE. — Zero of gage at Hartford is mean tide at Saybrook, Conn. Stages at Springfield referred to a datum 37.8 feet above Hartford base. Zero of gage at Holyoke is crest of dam which, since 1901, is 97.975 feet above Hartford base.

Comparative Heights of Principal Floods of the Connecticut River, 1639-1924
— Concluded

DATE		RIVER STAGES (IN FEET)			Peak Dis- charge at Sunderland, Mass. (Cubic Feet per Second)
Year	Month	Hartford, Conn.	Springfield, Mass.	Holyoke, Mass.	
1911	Apr. 16-17 . .	15.5	11.9	7.2	59,300
1912	Apr. 9-10 . .	21.2	16.1	9.3	84,500
1913	Mar. 28-29 . .	26.3	20.9	12.0	108,000
1914	Apr. 21-23 . .	21.9	17.0	9.9	90,000
1915	Feb. 26-27 . .	20.6	15.6	8.8	77,100
1916	Apr. 2-3 . .	20.8	15.6	8.9	74,900
1917	Mar. 29-30 . .	18.3	13.5	7.4	63,700
1918	Apr. 3-4 . .	18.8	14.0	7.9	70,200
1919	Mar. 29-30 . .	19.8	15.0	9.2	78,200
1920	Mar. 28-30 . .	22.5	17.3	9.83	97,000
1921	Mar. 10-12 . .	19.9	15.5	8.86	76,500
1922	Apr. 13-14 . .	24.5	19.4	11.35	103,700
1923	Apr. 7-8 . .	22.0	16.8	9.35	85,000
1924	Apr. 7-8 . .	20.7	14.5	7.8	60,900

SOME WORK DONE BY ENGINEERING FOUNDATION

A BRIEF RÉSUMÉ *

BUT little has been printed by the technical journals about Engineering Foundation. Some facts of its activities are, therefore, in order.

Founded in 1914, the first gift for endowment, \$200,000, was delivered to United Engineering Society as trustee on February 24, 1915. Only the income could be expended. Members of the Foundation Board were elected March 25, 1915, and met for organizing April 15. With no expendable funds yet accumulated and less than \$10,000 a year in prospect, no project could be undertaken immediately.

The great war was on. Within the year from the Foundation's first meeting, indications multiplied that the United States could not keep out. Scientific associations and engineering societies perceived the urgency for comprehensive organization. In June, 1916, under leadership of the National Academy of Sciences and the Founder Engineering Societies, the National Research Council was created. No funds were in hand. Engineering Foundation met the emergency by proffering its income. It provided offices in Engineering Societies Building and engaged Dr. Cary T. Hutchinson as secretary. Its founder, Mr. Ambrose Swasey, and Vice-Chairman Edward Dean Adams, each contributed \$5,000 to supplement the income. With this aid the Research Council was established and soon had funds from other sources. In 1919, when funds for endowment and a building were offered conditionally to the Academy and the Research Council, the two members of the Foundation just mentioned were among the contributors who made possible the purchase of the site near the Lincoln Memorial in Washington. From this beginning Engineering Foundation has co-operated continuously with National Research Council, especially

* Prepared by Alfred D. Flinn, Director of Engineering Foundation.

its Division of Engineering and Industrial Research. This division occupies offices in Engineering Societies Building, New York, as guest of the Foundation, and the Foundation has been assigned a room in the new building of the Academy and the Council.

During the war, fatigue failures of airplane parts led to study of this old problem of fatigue of metals. Funds for experimentation were not then forthcoming. In 1919, Engineering Foundation appropriated \$30,000 for a two-year program prepared by the National Research Council, to be carried out in co-operation with the University of Illinois. Industries became interested; the investigation is still in progress. General Electric Company, Allis-Chalmers Manufacturing Company, Western Electric Company and the Copper and Brass Research Association have contributed in cash \$61,000, besides services and materials. Several other companies have supplied materials and services, as have also numerous engineers and scientists. Contributions of services, facilities and publications by the University for the past five years could not have been purchased for less than \$50,000. Valuable additions to knowledge and theory have been made. Other important investigations in this country and abroad have been stimulated.

With research committees of its Founder Societies Engineering Foundation is co-operating in investigations of concrete and reinforced-concrete arches, steel columns for buildings and bridges, mining methods, rock-drill steels, properties of steam, bearing metals, lubrication, and strength of gears. Besides the Foundation's appropriations, totaling \$15,000, contributions from industries and other sources aggregate more than \$100,000.

In response to request from engineers in the far West, the Arch Dam Investigation was organized. The States of California and Oregon, the United States Bureau of Reclamation, the city of San Francisco, several power companies, four universities and a number of engineers in this and other countries are co-operating. Under the leadership of Vice-President W. A. Brackenridge, of the Southern California Edison Company, a special fund of \$100,000 is being raised for construction of a test dam 60 feet or more in height, upon which extensive ex-

periments during and after construction will be performed. Subscriptions of the companies and the Foundation total to date \$50,000. Additional contributions are being solicited. Observations on existing dams and dams under construction are in progress.

Engineering Foundation joined with National Research Council in the world-wide Marine Piling Investigation, in establishing the Advisory Board on Highway Research and the American Bureau of Welding, and in compiling a directory of research laboratories in United States industries.

Personnel Research Federation has been created by collaboration of Engineering Foundation with National Research Council "for furtherance of research activities pertaining to personnel in industry, commerce, education and government wherever such researches are conducted in the spirit and with the methods of science." A group of gentlemen are now providing \$100,000 for the support of this research organization for the next five years. This Federation publishes the "Journal of Personnel Research," now in its third volume.

Engineering Foundation has been also a bureau of information. It has contributed to promotion of research by publications, publicity, correspondence, and participation in meetings of various organizations. Notable among its publications have been a Directory of Hydraulic Laboratories in the United States and the Research Narratives. Since January, 1921, the Narratives have been mailed in leaflet form to many men prominent in finance, industry, engineering and education, and reprinted in newspapers of this and other countries even as far away as Australia, and in technical and other periodicals all over America and as distant as China. The first fifty Narratives were recently republished as a book by Williams & Wilkins Company, Baltimore, and are being sold by it for the Foundation at the cost of publication and delivery, fifty cents a copy. The book is having a wide sale.

The latest annual report shows that the total income of the Foundation for nine years, to December 31, 1923, was \$169,600. Expenditures have been as follows:

SOME WORK DONE BY ENGINEERING FOUNDATION. 379

Aid in establishing National Research Council	\$10,500
Support of Division of Engineering and Industrial Research	26,000
Research projects	57,000
Promotion of research	17,200
Administrative expenses	24,300
Total expenditures	\$135,000

There was accumulated for commitments and unforeseeable opportunities or emergencies a reserve of \$34,600.

During the past year, 190 leading engineers in 27 cities have accepted invitation to serve as informal local representatives. They include one State governor, many past and present officers of the national and local societies, and executives of important corporations.

Mr. Swasey continues his keen interest in the Foundation and is a frequent visitor. Although his generous contributions, totaling half a million dollars, have not yet been supplemented, as is his earnest desire and that of the Founder Societies, intimation has been received of several intended legacies of unknown amounts. Effort is being made to increase this endowment so that larger work may be done. The presidents and other representatives of the Founder Societies are aiding.

Many useful projects of the societies and the Foundation await larger resources. Nevertheless, by using its funds to inspire and aid and supplement, the Foundation has accomplished co-operatively some noteworthy results. As it approaches the end of its first decade, the Foundation looks forward to a future of greater service with the united support of the profession, of the industries, and of individuals who have built fortunes upon engineering.

MEMOIRS OF DECEASED MEMBERS**WALTER HOWARD SAWYER***

WALTER HOWARD SAWYER (born in Middletown, Conn., 1867; died December 21, 1923) son of John M. and Mary James Sawyer. Thrown on his own resources at an early age he worked his way through school and graduated from Bromfield Academy in Harvard, Mass., 1885 to 1886, with Shedd & Sawyer, Boston, Mass., on general office work, weir computations, and watershed surveys; winter 1886-1887, rodman and leveler, New York & Boston Rapid Transit Railroad, preliminary surveys; summer 1887 to spring 1890, with Ernest W. Bowditch, Boston; one year, engineer of construction of Dam No. 4 and in charge of construction on estate of H. O. Havemeyer in Greenwich and Stamford, Conn.; made preliminary surveys for sewerage system at Newburyport, Mass.; 1890, with E. A. Buss, Boston, Mass., on watershed surveys, and at Rumford Falls, Me., as resident engineer in charge of surveys and construction; 1891-1892, at Burlington Woolen Mill, Winooski, Vt., the latter year in the laboratory analyzing dyestuffs and oils; 1893, employed in development of process for recovery of waste indigo from waste liquors of woolen mills; 1894 to January, 1902, with Edward Sawyer, Boston, making weir and current meter measurements of flow of water; inspection of water wheels and general work of computing the amount of water used at the different mills at Lewiston, Me., preparing engineering facts in legal cases (question of water rights); in charge of construction of hydraulic development at Hooksett Falls, N. H.; obtaining facts for a report to Metropolitan Water Board on damages by proposed diversion of water; in charge of planning and construction of foundation for Massachusetts Storage

* Memoir prepared by H. S. Boardman and C. H. Pierce.

Warehouse Company, Boston; rebuilt Union Water Power Company's Dam No. 5 at Lewiston, Me.; also, from 1896, in private practice as follows: engineer for Samson Cordage Works, Shirley, Mass., planned and built storehouse, rebuilt portion of one of the dams after a washout, reconstructed portion of foundation of main mill, planned and built hydro-electric power station, repaired and strengthened reservoir dam, and planned and built an extension of private water system; made report on a storage system for Ludlow Manufacturing Company, Ludlow, Mass.; planned and built Pureoxia Distilled Water Plant, Boston; engineer for New England Sanitary Products Company, Boston, for designing garbage dock; designed and built 600 horse power hydraulic development for Androscoggin Mill, Lewiston, Me.; also engineer in various legal cases regarding water rights, etc.; employed by town of Lisbon, Me., in construction of combined sewerage system by North Conway Company, New Hampshire, in the determination of value of works.

In February, 1902, Mr. Sawyer was appointed agent of the Union Water Power Company, at Lewiston, Me., having responsible charge of the extensive storage system at the headwaters of the Androscoggin River and of the large water-power interests of that company at Lewiston. In 1909 he was appointed agent and hydraulic engineer of the Androscoggin Reservoir Company of Lewiston, — a company formed for the purpose of developing additional storage at the headwaters of the Androscoggin River, — in which connection he promoted and helped design and build the Aziscohos Dam, located in Lincoln Plantation, which created a storage basin with a capacity of 9,500,000,000 cubic feet. The development of the resources of these two companies was Mr. Sawyer's great aim in life.

In private practice he was a member of the firm of Sawyer & Moulton, engineers of Portland and Lewiston, Me., from 1909 to 1914, and of the firm Sawyer & Bean, consulting and hydraulic engineers of Lewiston, from 1918 until his death.

On April 23, 1900, Mr. Sawyer was married to Helen F. Hayes of Wellesley, Mass., who, with one daughter, Elizabeth Hayes Sawyer, and two sisters, survives him.

Mr. Sawyer was the inventor of an adjustable log sluice for high dams; of a method of measurement of water by electro-chemical means; of a method of sewage treatment; and the author of "Monograph on Ice Expansion."

He was widely consulted in water-power matters, especially water-storage problems, having been considered an authority on such questions. Professionally he will be remembered best for his successful work in developing the storage resources and in regulating the flow of the Androscoggin River in Maine. By his skill, his knowledge, his faith in his projects, his tact and honest methods, he brought his visions to practical completion, giving to that section of Maine a prosperity which it had never known before.

In civic matters he served his home city of Auburn, Me., as alderman and as member of the Water Board for two years, and was one of the leaders in the movement which gave the city its present city manager form of government. He was responsible for the formation of the Auburn Sewerage District and served as a member of the Board.

During the World War he was an active member of the Maine Public Safety Committee, secretary and treasurer of the Androscoggin County Committee of Public Safety, and member of the Federal Milk Commission of New England for the State of Maine.

Mr. Sawyer was a practical man, a firm believer in private enterprise and hard work, and possessed of a high sense of honor and justice. His business associates, neighbors, and many young men struggling for an education know the kind heart of the man whose keen judgment, pleasant word, and practical assistance made the day brighter and the path of life easier. His home was a delight to his friends; his love of flowers and children gave a glimpse of the splendid heart of the man.

One who knew him from boyhood paid him this tribute:

He was cheerful, earnest, thoroughgoing all the way along; to know him was to appreciate the full measure of his manhood. The world is richer for his journey through it, the poorer for the journey's having come to a too early end.

He was a member of the American Society of Civil Engineers, the Boston Society of Civil Engineers, and of the New England Water Works Association, a Charter Member and Past President of the Maine Society of Civil Engineers, a member of the American Society for Municipal Improvements, and of numerous clubs. On June 7, 1920, the honorary degree of Master of Science was conferred on him by the University of Maine in recognition of his attainments in the engineering field.

CHARLES ALFRED MAY *

CHARLES ALFRED MAY met a sudden and untimely death at Framingham, Mass., on December 21, 1923, as he was preparing to return home for the Christmas holiday.

Born in Fair Haven, Vt., on August 11, 1902, the son of Charles Leon and Mabel M. May, he attended the public schools of that town and was graduated from the high school as valedictorian of his class.

Coming to Boston, Mr. May entered the Northeastern University; after a two-year course in civil engineering, he entered the employ of Apsinwall & Lincoln as instrument man, and was later employed by Barbour & Dixon as instrument man and inspector on the construction of sewerage works for the town of Framingham.

Mr. May was a junior member of the Boston Society of Civil Engineers, being admitted to membership on December 21, 1921, the second anniversary of which being, strangely enough, the date of his death.

Possessed of a quiet, unassuming disposition, making few acquaintances, but each one a friend, his one objective being success in his chosen profession, which seemed assured on account of his faithful, accurate and conscientious work, his passing is indeed a loss to all who knew him.

* Memoir prepared by F. W. Haley.

BOSTON SOCIETY OF CIVIL ENGINEERS

FOUNDED 1848

PROCEEDINGS

MINUTES OF MEETINGS**BOSTON SOCIETY OF CIVIL ENGINEERS**

BOSTON, Sept. 30, 1924. — A regular meeting of the Boston Society of Civil Engineers was held today at the Boston City Club, and was called to order by the President, Edwin H. Rogers, at 6 P.M. There were about 40 members present.

The minutes of the previous meeting were approved as printed in the June JOURNAL.

The Secretary announced the names of those elected to membership by the Board of Government at meetings held on June 25, 1924, and Sept. 30, 1924.

June 25, 1924. — *Members:* H. L. Bowman, N. E. Hadley, Sumner Hazlewood, P. H. Kitfield, C. D. Proctor.

Sept. 30, 1924. — *Members:* Hyman Felderman, L. A. Gillett.*

Juniors: R. T. Lassiter, E. J. MacDonald.

In accordance with a recommendation of the Board, and upon a motion by Mr. F. O. Whitney, it was voted that the Board of Government be authorized to use the income from the permanent fund for the current year to such an extent as they deemed necessary in payment of the current expenses of the Society. In accordance with the By-Laws an affirmative vote

* Transferred from grade of Junior.

by the Society at two successive meetings is necessary to authorize such action.

The President, Edwin H. Rogers, announced that the American Society for Municipal Improvements had invited the members of the Boston Society of Civil Engineers and of the Northeastern Section, American Society of Civil Engineers, to be their guests at a dinner to be held this evening at the City Club. It was voted that the Society express to the American Society for Municipal Improvements its appreciation of their kindness in extending this invitation to them.

There being no further business the meeting was adjourned at 6.15 P.M.

The members then attended the dinner in the auditorium of the City Club. Following the dinner Harvey N. Shepard gave an illustrated talk on the "Temples of South India", and Albert A. Northrop presented, through the courtesy of Stone & Webster, Inc., a film on "Power", depicting the development of steam power up to the present time.

About 225 attended the dinner and joint evening meeting.

J. B. BABCOCK, *Secretary*.

APPLICATIONS FOR MEMBERSHIP

[October 15, 1924.]

THE By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

For Admission

BREITBEIL, CHARLES EDWARD, Boston, Mass. (Age 24, b. Louisville, Ky.) Attended Rensselaer Polytechnic Institute for one year and then transferred to civil engineering department of Massachusetts Institute of Technology and spent three years there. Experience began as draftsman in the bridge department of L. & N. Railroad in June, 1916, transferred to rodman and later to transitman. In 1918 became topographical draftsman on railway location party; in July, 1918, enlisted in Projects Division, United States Navy; served as assistant engineer in city of Louisville, Ky.; as municipal engineer in Middleborough, Mass.; on electric-mechanical investigation, and at present is a bridge designer, senior engineer assistant, Department of Public Works, Division of Highways, State House, City. Refers to A. O. Bradshaw, F. H. Morris, J. H. O'Connor, M. P. Smith, Sidney Smith, A. E. Sulesky.

CRANDALL, JAMES LYLE, Malden, Mass. (Age 57, b. New Bedford, Mass.) Educated in Halifax, N. S. Then engaged with his father in engineering construction, principally the design and construction of railway dry docks. In 1890 became engineer in charge of this work, since which time has been principally engaged in work of this character and other water-front structures. In 1918-20 was consulting engineer to United States Navy Department and United States Shipping Board. Now president and chief engineer of The Crandall Engineering Company. Refers to J. S. Crandall, R. W. Horne, E. S. Larned, R. H. Lindgren.

HOOPER, MORTIMER B. A., Dorchester, Mass. (Age 54, b. Attleboro, Mass.) Technical-training through I. C. C. Correspondence School and Lowell Institute. 1886-90 in City Engineer's office, Providence, R. I.; hydro-electric plant, 1891; New York, New Haven & Hartford Railroad, 1893; Boston & Albany Railroad, as draftsman to assistant engineer, 1895-1910; Boston & Maine Railroad engineering, 1910-12; with directors of the Port of Boston, 1912-14; New York, New Haven & Hartford Railroad, valuation work, 1914-21; New England Railroad Committee, railroad studies, 1922-23; and with Metropolitan Planning Board, assistant engineer, 1923-24. Refers to G. W. Cutting, Jr., E. H. Rogers, F. B. Rowell, G. T. Sampson, J. C. S. Taber.

LEWIS, HARRY, Boston, Mass. (Age 28, b. Boston, Mass.) Has had one year at Northeastern University and four years at Tufts Engineering School, where he graduated with degree B.S. in civil engineering in 1924. With George A. Fuller Construction Company during the summer of 1923

as instrument man, estimator and general engineering. Is now with the state of Massachusetts as senior assistant engineer, Grade B, at the State House. Refers to Robinson Abbott, A. B. Appleton, W. H. Lee, E. R. McCarthy.

PIERCE, JOHN FRANKLIN, South Weymouth, Mass. (Age 27, b. Essex, Mass.) Three and a half years in Massachusetts Institute of Technology, civil engineering course; Northeastern University, one year. Draftsman with the city of Medford, October, 1919, to June, 1920; in the sewer department, Milton, through the summer of 1922; with Roanoke Water Works, 1923-24; now with Metcalf & Eddy as resident engineer on construction. Refers to H. B. Alvord, L. G. Brackett, C. S. Ell, C. F. Joy, Jr., J. W. Raymond, Jr.

SHURTLEFF, ARTHUR A., Boston, Mass. (Age 54, b. Boston, Mass.) Graduate of Massachusetts Institute of Technology in 1894, and of Harvard in 1896. Landscape architect and consultant on town planning. Refers to H. P. Eddy, Desmond FitzGerald, R. K. Hale, H. I. Harriman, E. H. Rogers, J. R. Worcester.

TSAGARIS, DEAN PETER, Lowell, Mass. (Age 22, b. Greece.) Came to this country at the age of three years. Educated in the public schools, graduating from high school in Lowell in 1920, and entered Tufts College Engineering School, from which he graduated in 1924 in civil engineering. During his college years was engaged in property surveys and reinforced concrete mill building; shortly after graduating became connected with a private office in Lowell, where he is in charge of architectural engineering. Is now in partnership with T. W. Parke. Refers to Robinson Abbott, Pusey Jones, S. S. Kent, K. C. Reynolds, A. T. Safford.

For Transfer

KEITH, SCOTT, Newton, Mass. (Age 26, b. Newton, Mass.) Graduate of Massachusetts Institute of Technology, 1918; from October, 1918, to January, 1919, intensive naval architectural course at Massachusetts Institute of Technology. From January, 1919 to June, 1919, with a shipbuilding company; June, 1919, to June, 1920, assistant in civil engineering at Massachusetts Institute of Technology; June, 1920, to date, assistant engineer with Metcalf & Eddy. Refers to J. B. Babcock, C. E. Carter, H. P. Eddy, J. W. Raymond, A. L. Shaw, J. P. Wentworth.

MIRABELLI, EUGENE, Dorchester, Mass. (Age 26, b. Boston, Mass.) Graduate of Massachusetts Institute of Technology, 1918, degree of S.B. in civil engineering. January, 1919, to October, 1920, assistant engineer, McClintic-Marshall Company; 1920 to present, instructor in civil engineering at Massachusetts Institute of Technology. Refers to J. B. Babcock, H. A. Gray, Erwin Harsch, C. M. Spofford.

LIST OF MEMBERS

ADDITIONS

FELDERMAN, HYMAN	10 Pinckney St., Boston, Mass.
HAZLEWOOD, SUMNER	P. O. Box 710, Portland, Me.
MACDONALD, EDMUND J.	156 Mt. Vernon St., Newtonville, Mass.
NOYES, JOHN H. L.	401 City Hall, Boston, Mass.

CHANGES OF ADDRESS

BETTON, JAMES M.	1870 Wyoming Ave., Washington, D. C.
BREWER, BERTRAM	Black Rock Rd., Cohasset, Mass.
KIMBALL, JOSEPH H.	City Hall, Cumberland, Md.
LAMPIE, A. L.	11 Chester St., Allston, Mass.
PORTER, ARTHUR P.	Asst. Engr., Bureau of Design, Public Works Dept., City Hall, Richmond, Va.
WINSLOW, EARL H.	135 N. Charter St., Madison, Wis.
WYNER, HENRY I.	291 Brookline Ave., Brookline, Mass.

LIBRARY NOTES

RECENT ADDITIONS TO THE LIBRARY

U. S. Government Reports

Financial Statistics of Cities having a population of over 30,000. 1922.

Statistics of Railways in United States. 1922. 1909 and 1910.

U. S. G. S. Water Supply Paper, No. 514.

State Reports

Massachusetts Metropolitan District Commission, 4th annual report. 1923.

Municipal Reports

Brockton, Mass. Annual Report Sewerage Commission. 1923.

Brockton, Mass. Annual Report Board of Survey. 1923.

Brockton, Mass. Annual Report City Engineer. 1923.

Erie, Pa. Annual Report Commissioners of Water Works. 1923.

New York, N. Y. Annual Report Board of Water Supply. 1923.

New Orleans, La. Annual Report Sewerage and Water Board. 1923.

Miscellaneous

American Society of Heating and Ventilating Guide. 1924-25.

Coal Manual. F. R. Wadleigh.

Management's Handbook. L. P. Alford, Editor-in-chief.

Marine Piling Investigations. National Research Council.

Who's Who in America. 1924-25.

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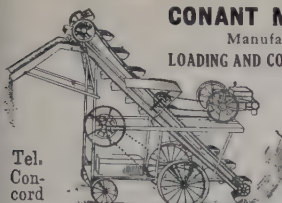
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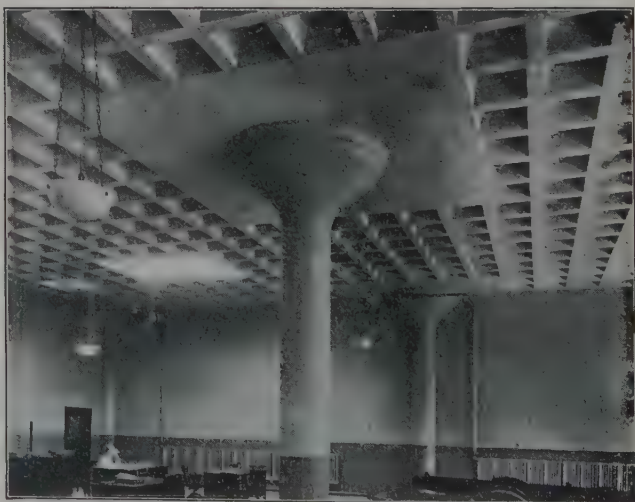
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